AEDC-TR-09-F-34

Pressure-Sensitive Paint Data on the Facility Aerodynamics Validation and Research (FAVOR) Model at AEDC

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December 2009

Final Report for Period October 2008

ARNOLD ENGINEERING DEVELOPMENT CENTER
ARNOLD AIR FORCE BASE, TENNESSEE
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE (DD-MM-YYYY)	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
xx-12-2009	Final Report	November 2009

4. TITLE AND SUBTITLE Pressure-Sensitive Paint Data on the Facility Aerodynamics Validation and Research (FAVOR) Model at AEDC	**5a. CONTRACT NUMBER** **5b. GRANT NUMBER** **5c. PROGRAM ELEMENT NUMBER**
6. AUTHOR(S) Sellers, Marvin E. Aerospace Testing Alliance	**5d. PROJECT NUMBER** 12450 **5e. TASK NUMBER** **5f. WORK UNIT NUMBER**
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Arnold Engineering Development Center Air Force Material Command Arnold Air Force Base, TN 37389-6001	**8. PERFORMING ORGANIZATION REPORT NO.** AEDC-TR-09-F-34
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Arnold Engineering Development Center Air Force Material Command Arnold Air Force Base, TN 37389-6001	**10. SPONSOR/MONITOR'S ACRONYM(S)** **11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

12. DISTRIBUTION/AVAILABILITY STATEMENT

Statement A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Available in the Defense Technical Information Center (DTIC).

14. ABSTRACT

Arnold Engineering Development Center (AEDC) recently acquired the Facility Aerodynamics Validation and Operations Research (FAVOR) model for use as a standard check model for Propulsion Wind Tunnel (PWT) 16T. The test article is a 5% scale model of the F-111 with new wings having a NACA 64-210 profile, a fixed sweep angle of 35 deg, and a span of 48 in. The plan is to periodically install the model and test across the facility capabilities to validate that tunnel operational characteristics have not changed. The first test of this model was recently completed as the baseline for future tests. While the internal balance and installed pressure taps were the primary source of data acquired, several other types of on- and off-body data were acquired. These included pressure-sensitive paint (PSP), background oriented schlieren (BOS), laser vapor screen, and planar doppler velocimetry (PDV). Pressure-sensitive paint data were acquired for demonstration of the techniques' capability to measure surface pressure and determine total vehicle loads and for use in computational fluid dynamics (CFD) validation. The PSP data were compared to and validated by conventional pressure data measured on the model and with total vehicle loads measured by the internal balance. This report documents the results from the PSP and presents the data comparisons.

15. Subject Terms

Pressure-sensitive paint, lifetime technique, integrated loads, surface pressure distribution, transonic flow, 16T, wind tunnel tests, PSP (pressure-sensitive paint), panel loads, PWT (Propulsion Wind Tunnel), pressure distribution, FIB7, PtTFPP (platinum tetra pentafluorphenyl porphine), HAAS (high-angle automated sting)

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19A. NAME OF RESPONSIBLE PERSON**
A. REPORT	**B. ABSTRACT**	**C. THIS PAGE**			Richard Roberts
					19B. TELEPHONE NUMBER *(Include area code)*
Unclassified	Unclassified	Unclassified	Same as Report	138	931-454-6225

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. 739.18

PREFACE

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Air Force Materiel Command (AFMC), Arnold Air Force Base, TN. The results of the test were obtained by the Aerospace Testing Alliance (ATA), the operations, maintenance, information management, and support contractor for AEDC, AFMC, Arnold AFB, TN. Testing was conducted in Propulsion Wind Tunnel 16T of the Propulsion Wind Tunnel (PWT) Facility from 13 – 29 October 2008 under Air Force Project Number 12450. The Propulsion Wind Tunnel 16T Air Force Project Manager was Richard Roberts, and the ATA Project Manager was Melissa Minter.

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1.0 INTRODUCTION

Arnold Engineering Development Center (AEDC) recently acquired the Facility Aerodynamics Validation and Operations Research (FAVOR) model for use as a standard check model for Propulsion Wind Tunnel (PWT) 16T. In addition, the test article is planned to be tested in several NASA facilities for comparison of test results. The test article is a 5% scale model of the F-111 with new wings having a NACA 64-210 profile, a fixed sweep angle of 35 deg, and a span of 48 in. The plan is to periodically install the model and test across the facility capabilities to validate that tunnel operational characteristics have not changed. The first test of this model was recently completed as the baseline for future tests. While the internal balance and installed pressure taps were the primary source of data acquired, several other types of on- and off-body data were acquired. These included pressure-sensitive paint (PSP), background oriented schlieren (BOS), laser vapor screen, and planar doppler velocimetry (PDV). Pressure-sensitive paint data were acquired for demonstration of the technique's capability to measure surface pressure and determine total vehicle loads and for use in computational fluid dynamics (CFD) validation. The PSP data were compared to and validated by conventional pressure data measured on the model and with total vehicle loads measured by the internal balance. This report documents the results from the PSP and presents the data comparisons.

2.0 APPARATUS

2.1 TEST FACILITY

AEDC Propulsion Wind Tunnel 16T is a closed-loop, continuous-flow, variable-density tunnel capable of being operated at Mach numbers from 0.06 to 1.60 and stagnation pressures from 120 to 4,000 psfa. The maximum attainable Mach number can vary slightly depending upon the tunnel pressure ratio requirements of a particular test installation. The maximum stagnation pressure attainable is a function of Mach number and available power. The tunnel stagnation temperature can be varied from approximately 60 to 160°F depending upon the available cooling water temperature. The tunnel is equipped with a scavenging system that removes combustion products when testing rocket motors or turbine engines.

The test cart used in Tunnel 16T was the high-angle automated sting (HAAS) cart, which has a 16-ft-square by 40-ft-long test section enclosed by porous walls. The wall porosity is fixed at 6% and is provided by regularly spaced 1-in.-diam holes that are inclined upstream at a 60-deg angle. The test section is completely enclosed in a plenum chamber from which air is evacuated at transonic and supersonic conditions, thus removing part of the tunnel airflow boundary layer through the porous walls of the test section. The HAAS test section has a side wall angle variation capability from -2.0 deg (convergence) to 0.8 deg (divergence). To compensate for the HAAS strut blockage, each side wall has a bulge section 6.0 in. deep. The model support system consists of a sector and sting attachment that has a pitch capability of -4 to 40 deg (position 2) with respect to the tunnel centerline and a roll capability of ±180 deg about the sting centerline. The general arrangement of the test section and test article is shown in Fig. 1.

2.2 TEST ARTICLE

The test article was a 5% scale model of the F-111 with new wings having a NACA 64-210 profile, a fixed sweep angle of 35 deg, and a span of 48 in. The model was mounted on a six-component balance to measure the aerodynamic forces and moments. Each wing had 22 pressure orifices (11 upper and 11 lower) located at a fixed buttline and the fuselage had 5 orifices, with all orifices connected to an electronically scanned pressure (ESP) module mounted inside the model. The model horizontal tails could be manually deflected using angled brackets but were fixed at zero degrees deflection for the PSP data. The inlets were faired over, and exit ducts were plugged to eliminate complications with flow through ducts corrections. Details of the test article are presented in Fig. 2. The actual pressure orifice locations and designations are listed in Table 1b. Since the model was designed prior to computer-aided drawing capabilities, there was no three-dimensional surface definition available for the fuselage, horizontals, or vertical tail. The model was scanned with a laser head mounted to a portable coordinate measuring machine. Unfortunately, the scan of the wings appeared to have some issues, so the surface file from the new wing design was used along with the scan of the remaining parts for the surface definition for PSP.

2.3 PRESSURE-SENSITIVE PAINT THEORY

PSP measurement systems exploit the sensitivity of certain luminescent molecules to oxygen density through the phenomenon of oxygen quenching. In a typical luminescent molecule, excitation by capture of a high-energy photon is followed by emission of a lower energy photon. As a result, the emitted photon will have a longer wavelength than the original exciting photon. The shift in emission wavelength from the absorption wavelength permits the measurement of emission intensity, or luminescence, with the use of appropriate filters. An alternate transition to the ground state is provided by collision with an oxygen molecule. Rather than emitting a photon, the excess energy of the luminescent molecule is absorbed by the oxygen molecule (oxygen quenching) during a collisional deactivation. Increasing amounts of oxygen increase the collisional deactivations, resulting in a decrease in the amount of luminescence. Since the number of oxygen molecules is directly proportional to the local pressure, low-pressure regions on the surface of a model will be brighter than regions of high pressure.

Two techniques exist for measurement of surface pressure using PSP: one is the “intensity” technique, and the other is the “lifetime” technique. In 2001, AEDC changed from the intensity technique to the lifetime technique to overcome limitations of the intensity method. A detailed description of the “intensity” technique can be found in Refs. 1 through 5. In the case of the lifetime technique, a pulsed light source is used to excite the paint to luminesce. The paint’s luminescence decays in an exponential fashion after the excitation is removed. If the excitation pulse ends at time zero, and the emitted intensity at that time is I_0, the emission then decays exponentially, following the relation:

$$I = I_0 e^{-t/\tau} \tag{1}$$

where I is the emitted intensity, t is time, and τ is the lifetime. The rate of decay increases with increasing pressure (i.e., oxygen concentration) and is illustrated in Fig. 3. The rise and decay of the PSP response to the pulsed excitation cannot be measured with an imaging device. Therefore, two images (Gate 1 and Gate 2) are acquired with different start times relative to the excitation pulse. These gates integrate the area under the curve, and the resulting ratio represents the lifetime characteristic of the PSP. Also, because the light emitted from a single pulse is insufficient for accurate measurement, the excitation pulse is repeated many times to build up the signal for each gate. The images are acquired in succession with the tunnel at test conditions.

2.4 PRESSURE-SENSITIVE PAINT

Two layers of paint are typically applied to the model surface. The first is a white substrate that helps reflect the luminescent light away from the model surface and provides a uniform background. The first layer consists of the proprietary FIB7 polymer, developed by the University of Washington, with Titanium Dioxide. The second, the PSP layer, contains the FIB7 polymer and the luminescent molecule Platinum Tetra Pentafluorphenyl Porphine (PtTFPP). The FIB7 polymer is porous to oxygen molecules, permitting contact with the PtTFPP molecules. The absorption and emission spectral characteristics of PtTFPP in FIB7 and the excitation source are presented in Fig. 4. Each spectrum was normalized by its peak output. The response of the paint to pressure and temperature was measured in a controlled environment using a special calibration apparatus. The response from a coupon sample painted at the same time as the model is presented in Fig. 5a. The intensity ratio from the paint calibration data was fit using nonlinear regression analysis and the following equation:

$$\begin{aligned} P = \quad & a_1 + a_2T + a_3T^2 + a_4T^3 + (IR)\ (b_1 + b_2T + b_3T^2 + b_4T^3) \\ & + (IR)^2(c_1 + c_2T + c_3T^2 + c_4T^3) + (IR)^3(d_1 + d_2T + d_3T^2 + d_4T^3) \\ & + (IR)^4(e_1 + e_2T + e_3T^2 + e_4T^3) \end{aligned} \tag{2}$$

where IR is the intensity ratio of Gate 1 over Gate 2 and T is the paint coupon surface temperature. The calibration coefficients ($a_{1\text{-}4}$ through $e_{1\text{-}4}$) are listed in Table 2. These calibration coefficients were used to calculate the surface pressure on the painted coupon sample, and the average residual curve fit error is presented in Fig. 5b. In addition, the standard deviation of the pressure across the sample (120,000 pixels for approximately 1 sq. in.) is presented in Figs. 5c and 5d as a pressure variation with pressure level. The image data from the calibration were binned (summed) over a 3 by 3 or 7 by 7 pixel area. The results illustrate a reduction in noise with averaging and are representative of the limitations of measurement accuracy.

2.5 PRESSURE-SENSITIVE PAINT DATA ACQUISITION SYSTEM

A schematic of the PSP data acquisition system (PSPDAS) used during the test is shown in Fig. 6. The PSP is excited by 40 light-emitting diode (LED) units, 10 LEDs per wall, which illuminate at a wavelength of 464 nm. The LEDs were pulsed on for 30 μs every 600 μs, for a 5% duty cycle, using a Berkley Nucleonics Corporation (BNC) 555 digital delay generator. The luminescence was measured with eight CoolSNAP K4 interline transfer cameras, each

with 2048 by 2048 pixel spatial resolution, and digitized at 12-bit (4096) gray level resolution. The interline transfer technology provides extremely accurate and repeatable exposure times necessary for the repeated experimental conditions required for the lifetime technique. The cameras also have a unique capability to accumulate the charge from thousands of individual pulses on the charge-coupled device (CCD) before readout. As a result, the read noise is significantly less than that of conventional interline transfer cameras, which read out after each pulse. The camera gating was controlled with the delay generator to maintain the temporal relationship between the LED pulse and the camera exposure. The luminescent light emitted by the paint was passed to the camera detector through a custom narrow-bandpass filter centered at 650 nm with a full width at half maximum of 40 nm. A Linux cluster, with a front end and eight nodes (each with dual processors), executed the data acquisition software that controlled the delay generator and cameras. One camera was connected to each node via a PCI card and fiber optic cable. A supply of pressurized air was used to cool the PSP equipment since it was exposed to the low-pressure environment in the tunnel plenum area.

3.0 PROCEDURES

3.1 TEST CONDITIONS

The test was conducted at Mach numbers from 0.4 to 1.1 at a unit Reynolds number of 2.5 million/ft. The nominal test conditions established during the test are listed in Table 3. After establishing the desired test condition, data were recorded at selected angles of attack by pausing for completion of data acquisition. The angle of attack was varied from -3 to 40 deg (maximum angle decreased with increasing Mach). A test run number summary is presented in Table 4.

3.2 DATA ACQUISITION

Model aerodynamic loads data, conventional pressure data, and PSP images were acquired automatically by the facility computer. The facility computer set the requested model attitude and sent the run and sequence number to the PSPDAS, indicating that PSP data were to be acquired while the facility computer acquired the loads and conventional pressure data. The PSPDAS set the delay generator for Gate 1 to pulse the LEDs for 30 μs and acquire a 30-μs image during the LEDs pulse for a predetermined number of pulses. Once the image acquisition for Gate 1 was complete, the delay generator was set for Gate 2 to pulse the LEDs for 30 μs and acquire a 30-μs image 5 μs after the LED pulse ended. The number of pulses for each gate was set to provide the brightest image possible, without saturation, for each test condition. The images for all eight cameras were acquired simultaneously and stored locally on each node. A file containing tunnel conditions, aerodynamic coefficients, and conventional pressure data was generated for each data point and stored on the PSPDAS. The PSPDAS returned a code to the facility computer once data acquisition was completed so the facility could advance to the next attitude or test condition.

3.3 PRESSURE-SENSITIVE PAINT DATA REDUCTION

Taking the ratio of the two gates, the effect of nonuniformities in illumination and paint thickness are negated, and there is no need to make a flat-field correction for pixel gain variation since identical pixels are ratioed. The raw images for both gates are first corrected for bias in the CCD (bias resulting from dark current charge accumulation) by subtracting a dark image with the equivalent number of pulses for each gate. The ideal process would be to generate a normalized (for the number of pulses) intensity ratio image by taking the pixel-by-pixel ratio of the Gate 1 image divided by the Gate 2 image as follows:

$$IR = \frac{\left(I_{Gate1} - I_{Dark1}\right)/\left(\#Gate1\,Pulses\right)}{\left(I_{Gate2} - I_{Dark2}\right)/\left(\#Gate2\,Pulses\right)} \tag{3}$$

However, analysis of PSP data taken with constant pressure on the model surface (at atmospheric or subatmospheric pressures) indicates the paint response differs from the laboratory calibration and is not uniform. Also, the possibility of red light leakage from the blue LEDs or blue light leakage through the camera filter will only affect the Gate 1 measurement (when the LED is on) and not be ratioed out. The nonuniform paint response is *independent* (fixed to the paint) of camera view angle and model attitude while the leakage effects (bias) are *dependent* on camera view angle and model attitude. Data acquired at a set of uniform pressures in the wind tunnel (e.g., 400, 800, 1,200, and 2,060 psfa) at each requested model attitude were used to compute the bias and slope corrections (s_0 and s_1) for an adjustment to the intensity ratio at each grid point on the model surface as follows:

$$IR_{adjusted} = \left(\frac{\left(I_{Gate1} - I_{Dark1}\right)/\left(\#Gate1\,Pulses\right) - Bias}{\left(I_{Gate2} - I_{Dark2}\right)/\left(\#Gate2\,Pulses\right)} - s_0\right)\Big/ s_1 \tag{4}$$

The average bias adjustment is captured in the slope correction with the residual variation as model attitude varied captured in the bias term. As a result, the bias corrections were very small and are not presented. The spatial distribution and magnitude of the slope corrections are presented in Fig. 7. The result of applying this adjustment was a reduction in the PSP data uncertainty as compared to the pressure orifice measurements.

Registration targets were applied to the model, and their positions in model coordinates were measured using a portable coordinate-measuring machine (CMM). The registration targets were used to relate the two-dimensional (2D) image coordinate system to the three-dimensional (3D) model coordinate system. The photogrammetry methods described by Bell (Ref. 6) and Ruyten (Ref. 7) were used to overlay the 2D intensity ratio images from each camera onto a 3D mesh grid of the model surface. For each vertex point in the grid, a 7 by 7 average of the adjusted intensity ratio was extracted from the 2D image. If a vertex point was visible to more than one camera, the intensity ratio data were averaged using a weighting factor that was a function of the camera viewing angle. The surface pressure at each vertex was calculated using Eq. (2) with the adjusted intensity ratio ($IR_{adjusted}$) and calibration coefficients (a_{1-4} through e_{1-4}). The model surface temperature, substituted for T in Eq. (2),

was estimated using the turbulent boundary-layer recovery factor of 0.896 given by Schlichting (Ref. 8) and the following equation:

$$T_{surface} = r(TT - T_\infty) + T_\infty \tag{5}$$

where TT is the stagnation temperature, T_∞ is the freestream temperature, and r is the recovery factor. The surface pressure data (P) were converted to pressure coefficient data using:

$$CP = \frac{(P - P_\infty)}{Q_\infty} \tag{6}$$

where P_∞ and Q_∞ are the freestream static and dynamic pressure, respectively, calculated by the facility. The PSP data were adjusted to match the conventional pressure data to account for differences in estimated and actual surface temperatures and other unknown error sources. Differences between the conventional pressure data and PSP data at known corresponding locations on the model surface were calculated. These data were used to generate an average CP offset and slope correction that was applied to the 3D data file. The CP offset (converted to psf) and slope (in percent change) corrections that were applied to each data point are listed in Table 4. A PLOT3D type function file was generated for each data point with pressure coefficient data at each vertex point in the grid.

The PSP data practically provide a continuous distribution of surface pressure over the model surface. In an attempt to simplify and keep familiar the analysis of surface pressure data, virtual pressure taps were generated at six buttline stations on each wing, three stations on each horizontal tail, four waterline stations on the vertical tail, four fuselage stations on the body, and centerline cuts along the top and bottom of the fuselage. These data could be plotted as pressure profiles for comparisons with the conventional pressure data and with left and right surfaces for symmetry. The virtual pressure orifice locations and designations are listed in Table 1a. The sting cavity pressure was applied to surfaces representing the model and engine duct base as an approximation. The PSP data were numerically integrated for the total vehicle, the individual wings and horizontal tails, and the vertical tail to produce six-component forces and moments for each surface. The moment reference center for each surface was F.S. 27.150, B.L. 0.0, and W.L. 8.50. The sign was changed for all right surface side forces and yawing and rolling moments so that direct comparisons between the left and right surfaces of the model could be made (left-wing axis system).

4.0 RESULTS AND DISCUSSION

4.1 PRESSURE MEASUREMENT COMPARISONS

Verification of the PSP data is possible by comparison with the conventional pressure data, which is assumed to be truth. Also, the PSP data can be validated by comparing the data

from the left and right sides of the model which are supposed to be symmetrical. These comparisons for the six buttline stations on the wings are presented in Figs. 8-11.

The Mach number 0.4 PSP data presented in Fig. 8 are the noisiest because the surface pressures are closest to atmosphere and have the least amount of pressure variation across the wing. This is most evident on the lower surface of the wings with indications of rippling pressure distributions that should be fairly smooth and the PSP data indicating asymmetry on the two outboard sections of the wing where there should be none. However, comparisons of the two sections with conventional pressure data indicate fairly good agreement from minimum to maximum angle of attack. Some asymmetry occurs on the upper outboard wing sections at 8 deg (Fig. 8c) that is the result of asymmetric separation of the low pressure bubble on the wing. Once the wing reaches 14 deg angle of attack, the flow is fully separated outboard of buttline station 8.0 and the PSP data agree on both upper wing surfaces.

The Mach number 0.8 PSP data are presented in Fig. 9 and illustrate very good agreement with the conventional pressure data on the inboard upper and lower surface of the wings. The outboard upper surface also has very good agreement, but the lower surface has larger disagreement with the conventional data. The main reason for the disagreement was insufficient light emitted from the paint because the number of pulses acquired was too low. A repeat of this condition with increased pulses improved agreement (not presented) with conventional pressure measurements. A significant asymmetry is present in the PSP data on the upper wing surface between 7 and 12 deg angle of attack, after which the flow is separated and the PSP data are symmetric again.

The Mach number 0.95 PSP data are presented in Fig. 10 and illustrate excellent agreement with the conventional pressure data as well as having excellent symmetry between left and right wings. The one exception of PSP symmetry is for 12 deg angle of attack and once again is the result of asymmetric separation on the upper wing surface.

The Mach number 1.1 PSP data are presented in Fig. 11 and illustrate excellent agreement with the conventional pressure data as well as having excellent symmetry between left and right wings. The pressure orifice CWLO9 appears to be bad as compared with neighboring orifices and with the PSP from both wings. This was verified in the error analysis of the PSP data that was performed.

4.2 PSP ERROR ANALYSIS

Although the PSP data were "anchored" by the conventional pressure measurements using an average offset, there still remains a residual error between the paint and each individual orifice. The PSP measurement error can be estimated by computing the difference between the PSP and conventional pressure measurements on the two wings and the limited fuselage locations. The average pressure error of all data points at each Mach number and for each pressure orifice is presented as symbols in Figs. 12a-f, and the average error for all Mach numbers combined is presented in Fig. 12g. The error bars represent the $\pm 1\sigma$ variation of the average error for each orifice. The pressure orifices CWIL1 and CWIL2 were removed from the error analysis because their positions on the wing were suspect and had significantly large errors. Likewise, CWOL9 was removed because the ESP measurement was suspect

as a result of comparison with neighboring values and PSP data. The average error of all orifices for Mach 0.4 was 10.8 psf with a standard deviation of ±7.6 psf and is not fairly good for this low-speed condition. The average error for Mach 0.8 was 13.5 psf with a standard deviation of ±11.6 psf, but a repeat of this condition with an increased number of pulses was 11.5 psf and ±7.6 psf. The standard deviation was largest for the outboard lower wing section for the initial run but shows significant improvement on the repeat run that had an increased number of pulses acquired. This is a good indication that maximizing the emitted light from the PSP reduces the measurement noise. The average error for Mach 0.9 was 9.1 psf with a standard deviation of ±7.4 psf, and the repeat was 10.0 psf and ±7.7 psf. The average error was lowest for Mach 1.1 at 8.4 psf with a standard deviation of ±6.0 psf. When combining all Mach numbers together, the average error was 10.4 psf with a standard deviation of ±9.1 psf. These measurement errors are very good for PSP; however, the region of evaluation is limited.

4.3 INTEGRATED FORCE AND MOMENT COMPARISONS

A comparison of measured balance loads with the PSP integrated loads for the total vehicle are presented in Fig. 13. The PSP normal force and pitching moment agree very well with the balance measurements at all Mach numbers with the exception of the PSP pitching moment at Mach 0.4 for angles of attack less than 14 deg. The most likely reason is the very small and strong low-pressure region along the leading edge of the wings. A visualization of this will be presented in the next section. A small error in the mapping of this gradient can significantly affect the integrated pitching moment. The PSP normal force and pitching moment data for the initial Mach 0.8 run at the highest angles of attack start to deviate from the balance data as a result of the poor measurement on the lower wing surfaces. The data for the repeat run agree very well. The side force and yawing moment should be near zero since the model is supposedly symmetric. While the balance side force is near zero, a significant yawing moment was measured, especially when asymmetric separation occurred over the wing. This separation is evident in the large rolling moment generated and coincided with a spike in the yawing moment. This must be a coupling yaw moment because the side force did not have a corresponding change. The PSP yaw and roll plane data typically tracked the balance data but with some offset. It is difficult to pinpoint the source of the error in the PSP data because small forces at large distances (i.e., wing tips) from the moment reference center can introduce large moment errors. The PSP axial force tracked the balance measurement for all conditions but was always low. This was as expected because the PSP does not measure skin friction force, which is measured by the balance.

To provide a better understanding of the difference between PSP and balance data, the two were subtracted to generate delta loads (balance - PSP) and are presented in Fig. 14. The Mach 0.4 data illustrate a noisy result at angles of attack less than 14 deg and a large PSP rolling moment error. This is the result of noisy data across the surface of the model because of the high absolute surface pressure, where PSP does not perform well. The data at Mach 0.8 illustrate the improvement made by increasing the number of pulses for the repeat run. Again, the higher surface pressure noise for the first run resulted in a significant normal force and pitching and rolling moment error and was the result of poor measurement on the lower surface of the wings, especially toward the wing-tips. The data at Mach numbers 0.95 and 1.1 compare very well and are within 10% of the measured load. A significant observation is

the increasing axial force error as Mach number increases. This corresponds with the expected increase in skin friction as Mach increases.

Another validation of the PSP data can be performed by comparing the symmetry of integrated loads for the left and right wings as presented in Fig. 15. At Mach 0.4 there is a significant difference between the wing normal force and pitching and rolling moments. The wing rolling moment difference explains where most of the rolling moment error comes from in the total integration. However, the normal force and pitching moment error do not show up in the total loads. These must be canceled by errors on other surfaces. The normal force and pitching and rolling moment data at the other Mach numbers agree very well with the exception when asymmetric wing separation occurs. The wing axial force agrees very well at all conditions. With the exception of the Mach 0.4 data, the errors in the total integrated loads must be occurring on other surfaces of the vehicle. While not presented herein, the horizontal tail loads agreed very well, and the vertical tail contributed small loads to the total. Integrations of the left and right halves of the fuselage did have significant differences that contributed to the error of the PSP.

4.4 FULL SURFACE PRESSURE DISTRIBUTIONS

One of the advantages of PSP is the detailed surface pressure distribution that it provides. Surface pressure distributions on the upper and lower surfaces of the model for Mach 0.4 are presented in Fig. 16. At Mach 0.4 the pressure gradients are greatest on the upper wing, fuselage, and horizontal tail surfaces. As discussed earlier, a strong low-pressure region can be seen on the leading edge of the wing at 8 deg angle of attack. Strong vortices generated by the wing glove and the wing glove intersection and the effects on the wing pressure distribution can be seen at 14 deg angle of attack. Vortices are also generated from the leading edge of the horizontal tails.

Pressure distributions for Mach 0.8 are presented in Fig. 17. A strong low-pressure region is generated by the wing at negative angles of attack. The symmetry of the flow at 5 deg angle of attack is illustrated in Fig. 16b, while the asymmetric separation is visible in Figs. 16c and 16d. Symmetric conditions exist once the angle of attack gets to 14 deg and beyond.

Pressure distributions for Mach 0.95 and 1.1 are presented in Figs. 18 and 19. Strong shocks are present on the wings at 5 and 10 deg angle of attack after which separation starts to occur. Again, the symmetry prior to separation is evident in the images and returns at 14 deg for Mach 0.95 and after 14 deg for Mach 1.1.

5.0 SUMMARY

Pressure-sensitive paint data were acquired on the FAVOR model in 16T for demonstration of the technique's ability to measure surface pressure and determine total vehicle loads and for use in CFD validation. The PSP data were compared to and validated by conventional pressure data measured on the model and with total vehicle loads measured by the internal balance. Some conclusions and observations from the test are as follows:

- The PSP pressure distributions had excellent agreement with the conventional pressure measurements except for the Mach 0.4 and initial Mach 0.8 runs. The main reason for the disagreement was noise in the PSP surface pressure measurement. The comparison between left and right surface PSP measurements was excellent when symmetry was present. Asymmetrical conditions that occurred with the abrupt wing stall were captured by the PSP in fine detail.

- The error analysis of the PSP measurements indicates the average error of the PSP to be approximately 10 psf when compared to the conventional measurements. However, by evaluating the error at each Mach number, a trend is observable that illustrates an improvement in PSP accuracy as Mach number increases, primarily the result of decreasing freestream pressure. In addition, the need to maximize the amount of emitted light from the PSP to reduce measurement noise is demonstrated in the Mach 0.8 repeat run. The region of error evaluation is limited to the two wing sections that were instrumented and the few fuselage pressure orifices.

- The total integrated normal force and pitching moment from the PSP data agree within 10% of the balance measured loads for most conditions. The integrated axial force was low compared to the balance measurement because the PSP cannot measure skin friction. The axial force error increased as Mach number increased because skin friction increases with Mach over the tested conditions. The yawing and rolling moment errors were significant, and the source was not easily identifiable. However, comparisons of the rolling moments for the left and right wings were excellent except for Mach 0.4. The vision for PSP was to reduce, or possibly eliminate, the need for a model with numerous pressure orifices to determine distributed loads in the structural analysis effort, not to replace a balance.

- Detailed pressure maps provided by the PSP data enable evaluation of the surface flow patterns and identification of flow disturbance sources. Also, the data will be very useful for CFD validation.

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2. Sellers, M. E. “Demonstrations of a Pressure Sensitive Paint Data System in the AEDC Propulsion Wind Tunnel 16T.” AEDC-TR-95-8, October 1995.

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4. Sellers, M. E. “Pressure Sensitive Paint Data on the Transonic Technology Wing Demonstrator (TST) in the AEDC Propulsion Wind Tunnel 16T.” AEDC-TR-98-3, June 1998.

5. Sellers, M. E. “Application of Pressure Sensitive Paint for Determining Aerodynamic Loads on a Scale Model of the F-16C.” AIAA Paper 2000-2528, 21st AIAA Aerodynamic Measurement Technology and Ground Testing Conference, Denver, CO, June 2000.

6. Bell, J. H. and McLachlan, B. G. “Image Registration for Luminescent Paint Sensors.” AIAA Paper 93-0178, 31st Aerospace Sciences Meeting, Reno, NV, January 1993.

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8. Schlichting, H. *Boundary Layer Theory*. McGraw-Hill, New York, 1979 (Seventh Edition).

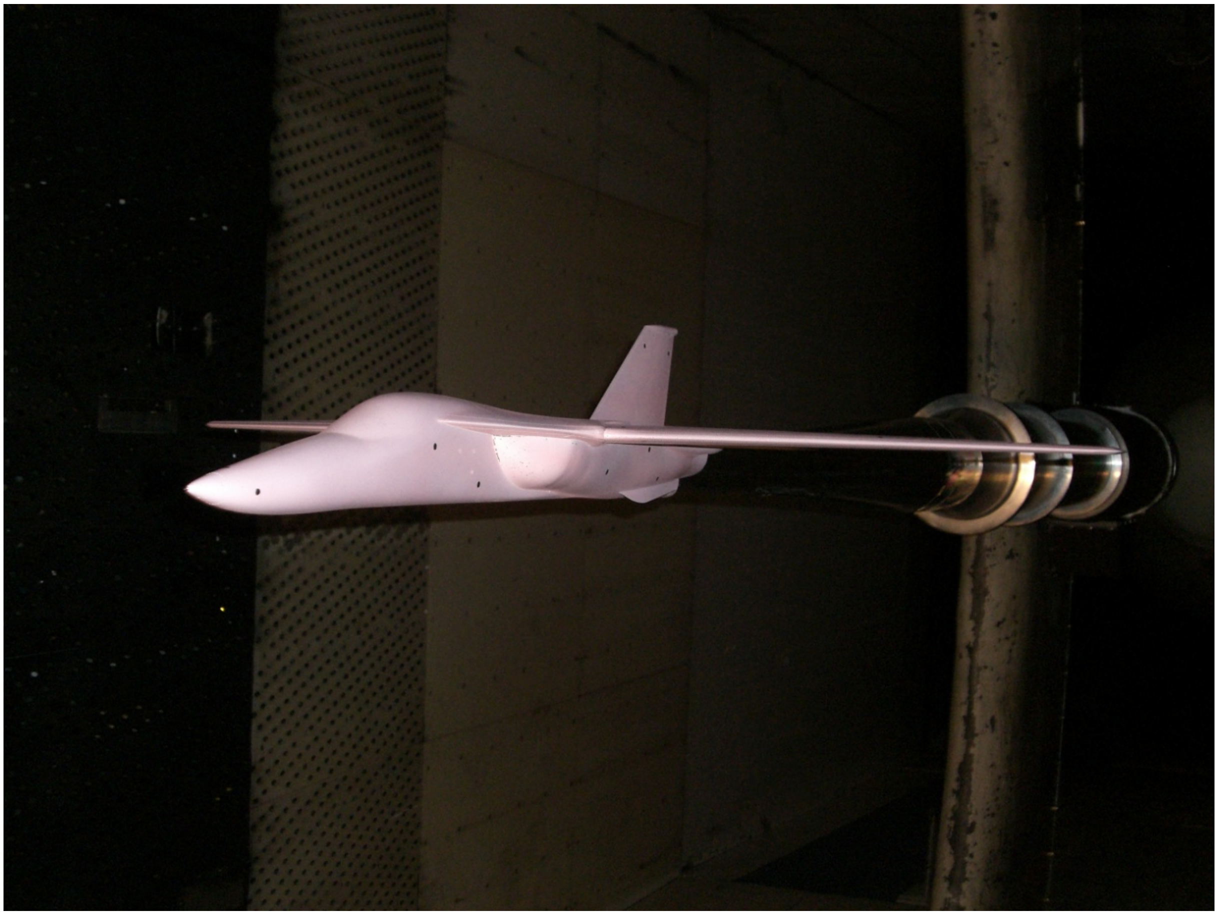
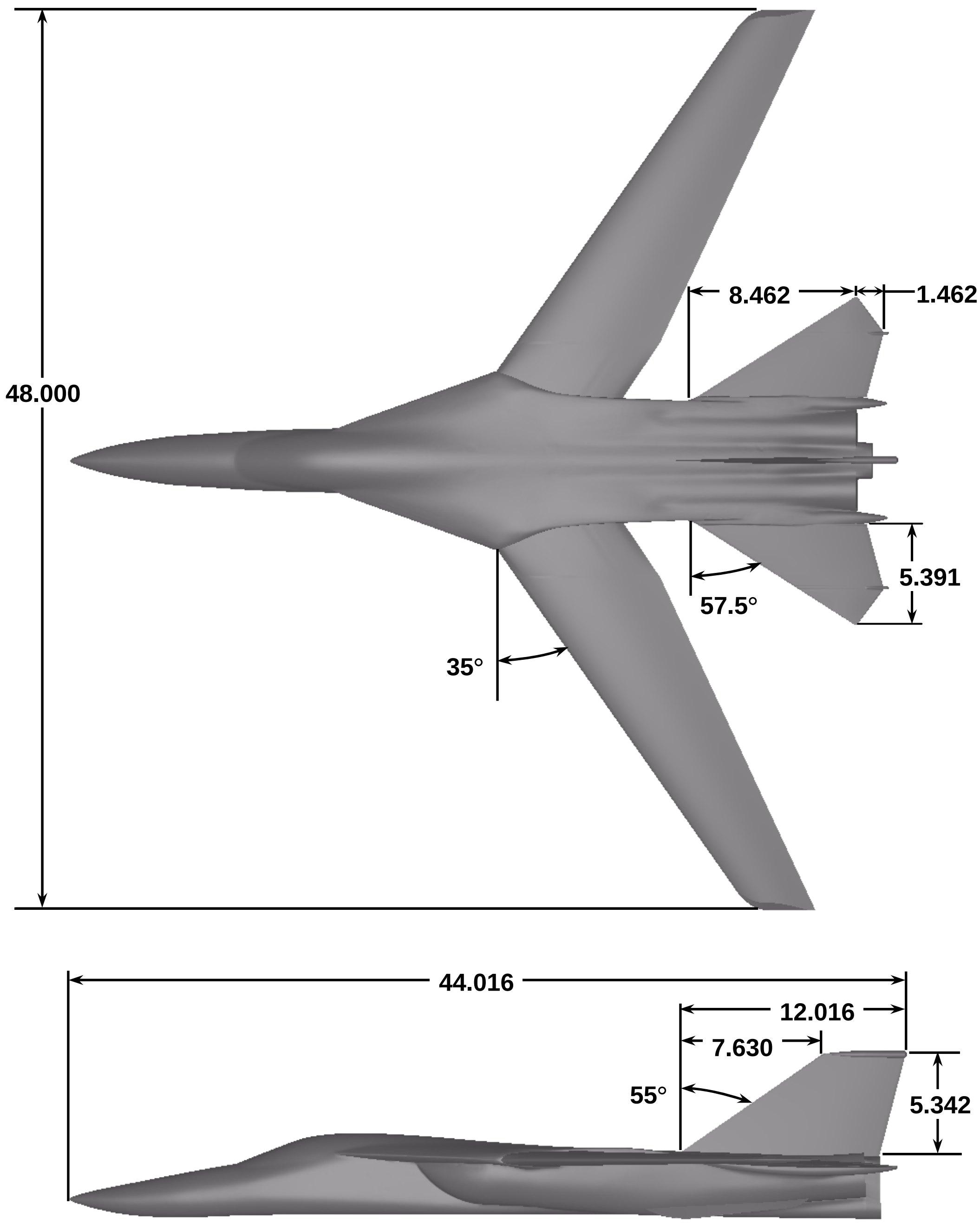


Figure 1. FAVOR Test Article Installation in the HAAS Cart



Dimensions in Inches

Figure 2. FAVOR Details

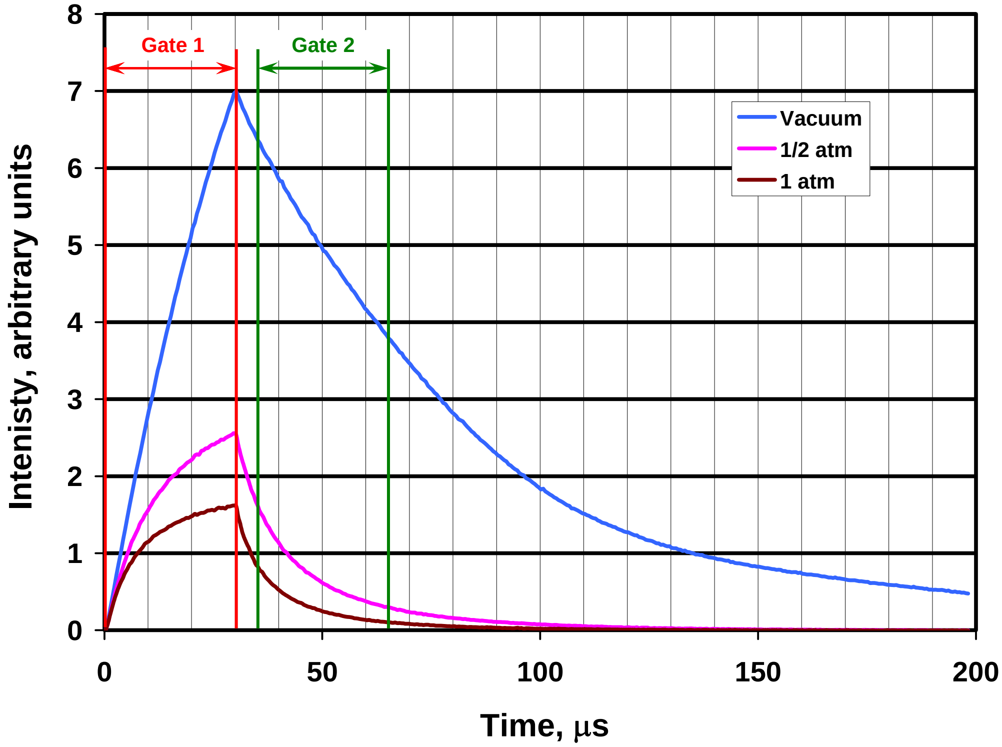


Figure 3. PSP Lifetime Response to Pressure

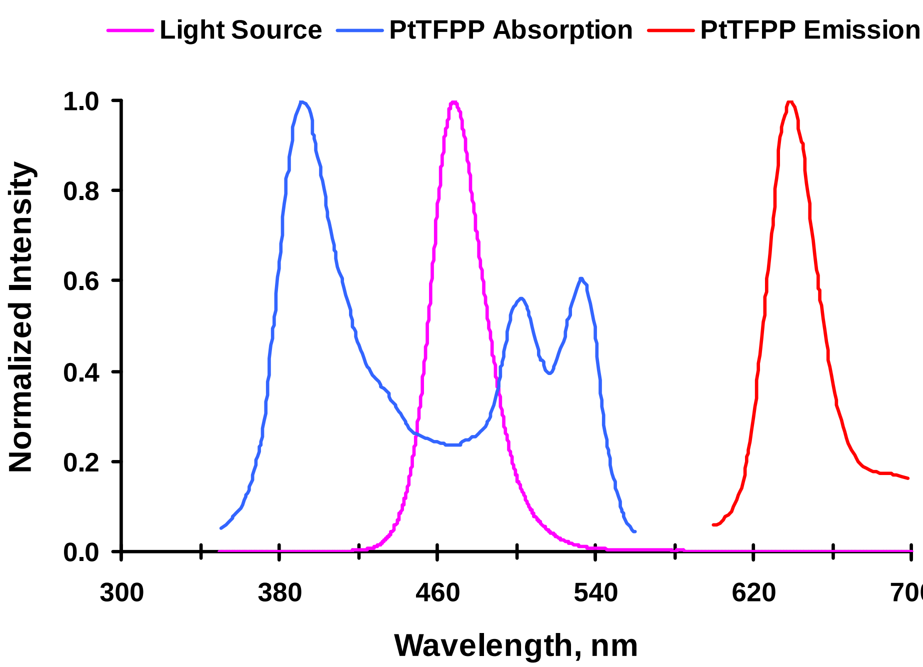
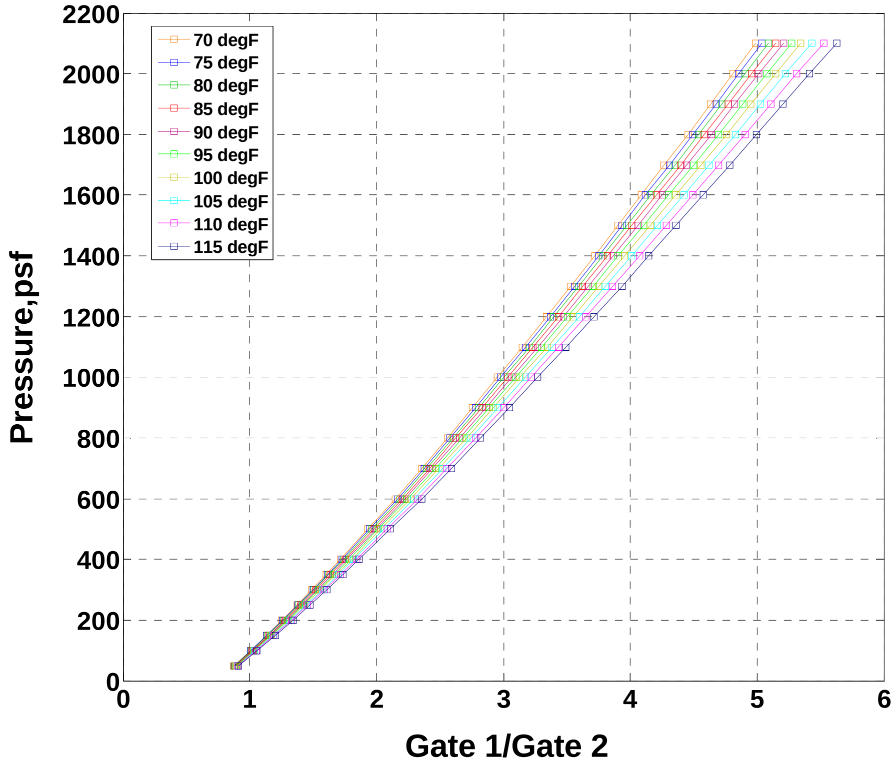
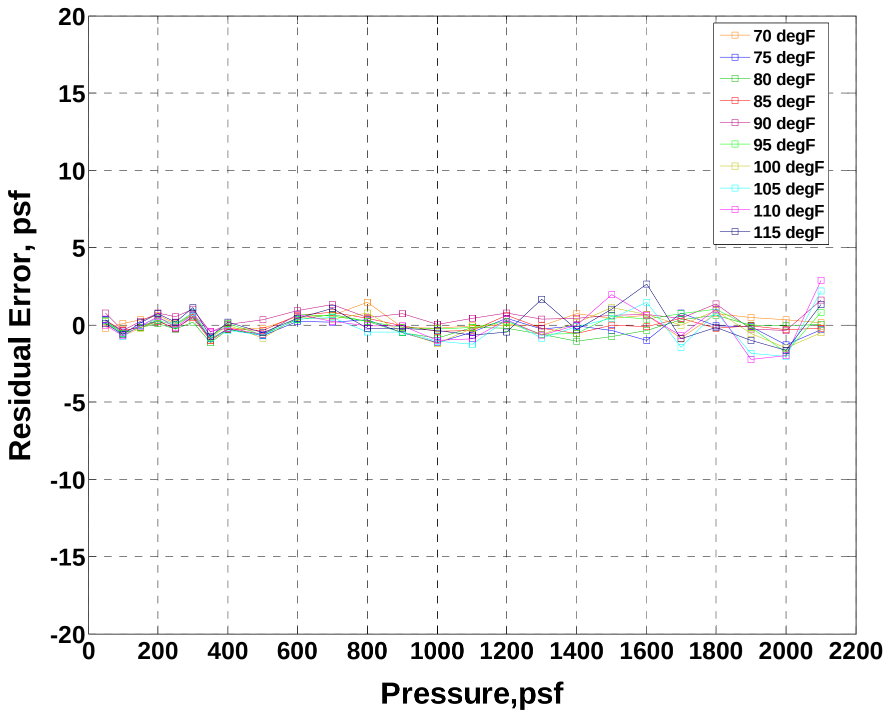


Figure 4. Spectral Characteristics of PtTFPP in FIB7 and Filtered Light Source

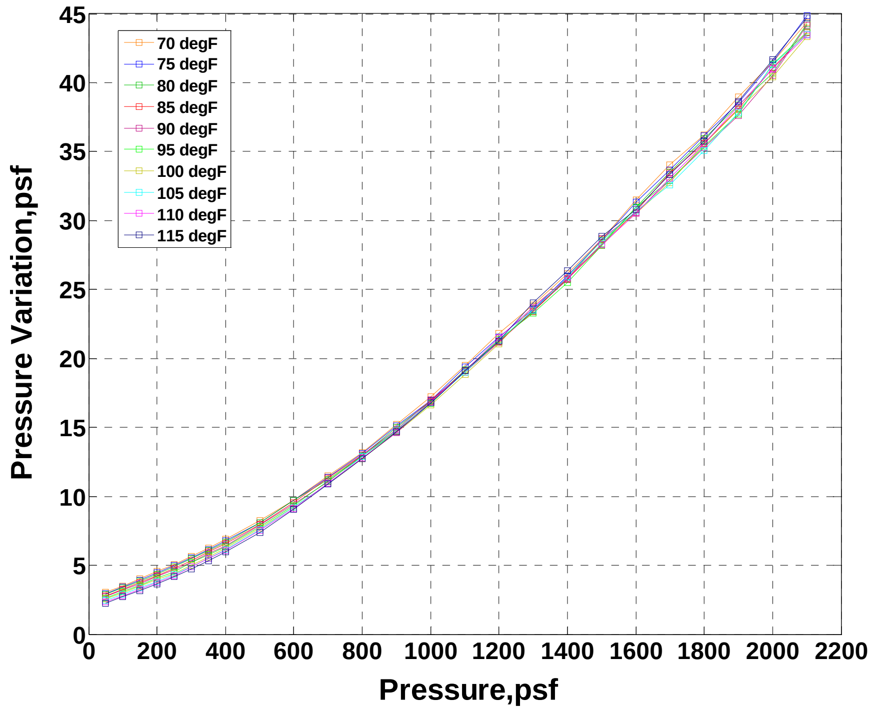


a. FIB7 PSP Pressure and Temperature Characteristics

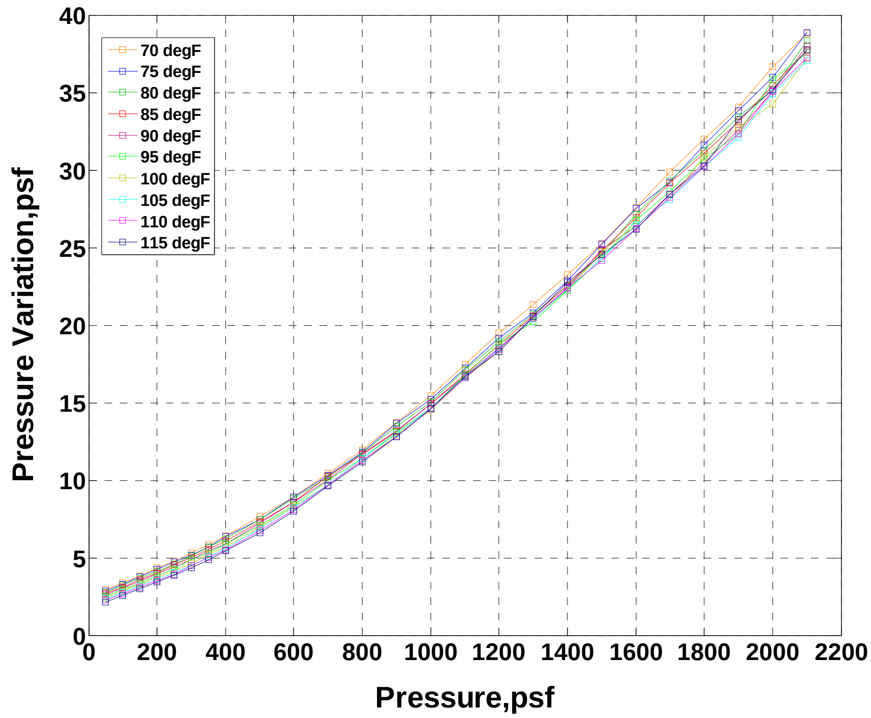


b. Curve Fit Residual Error

Figure 5. FIB7 PSP Calibration Results



c. Pressure Variation on PSP Sample, 5 by 5 Average



d. Pressure Variation on PSP Sample, 7 by 7 Average

Figure 5. Concluded

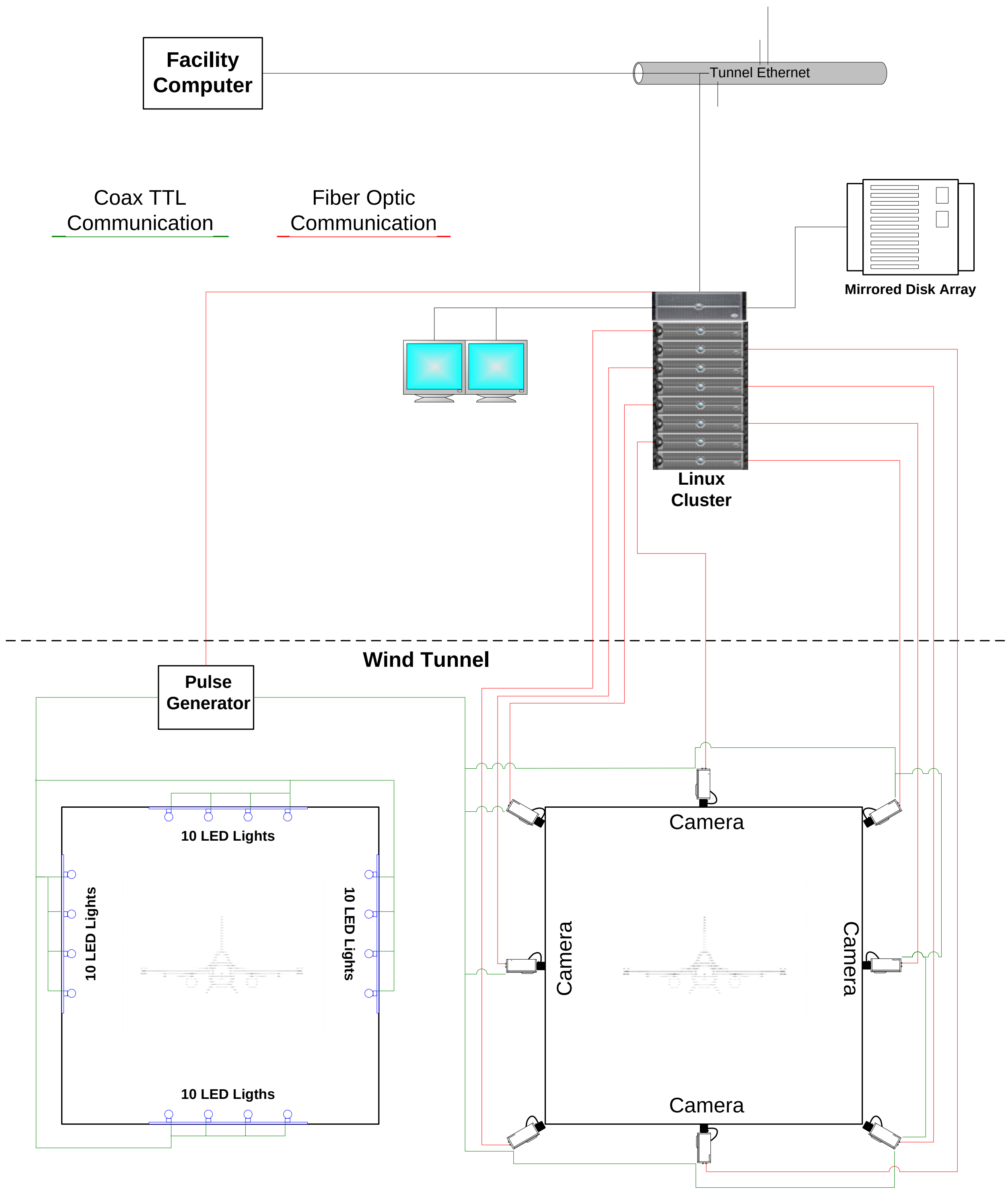


Figure 6. PSP Data Acquisition System

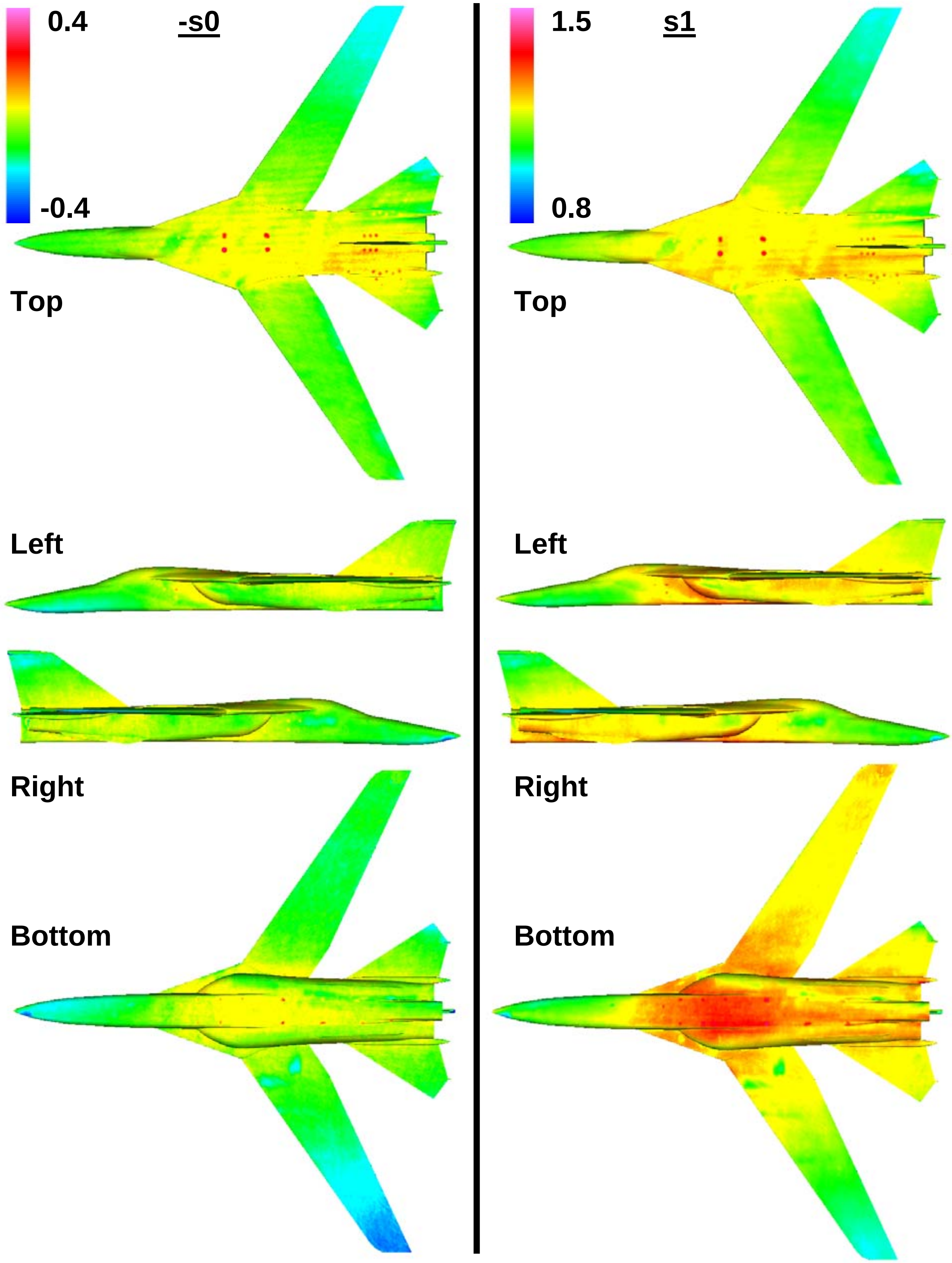
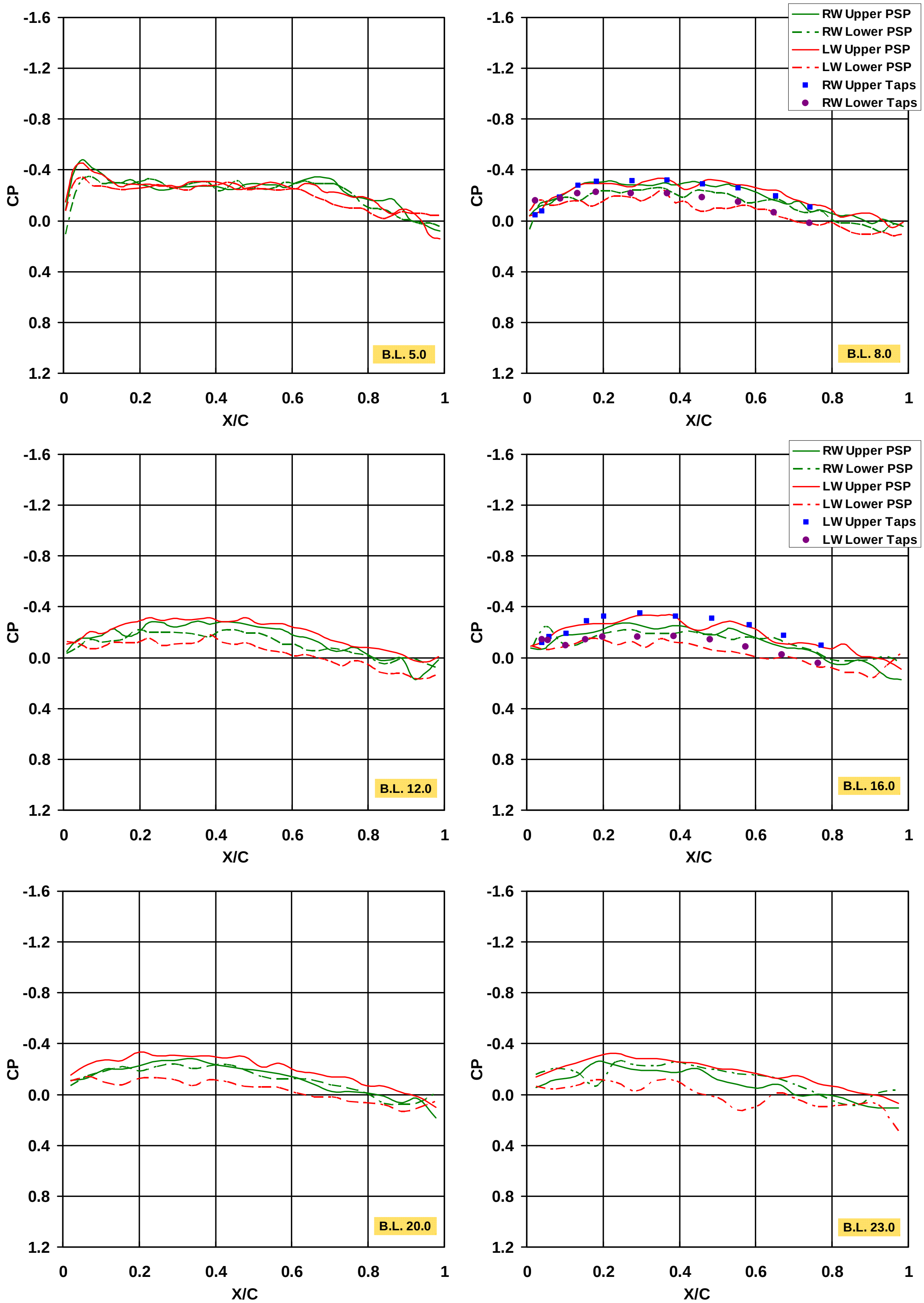


Figure 7. PSP Slope Corrections.



a. Alpha 0 deg.
Figure 8. Mach Number 0.4 Wing Pressure Coefficient Comparison.

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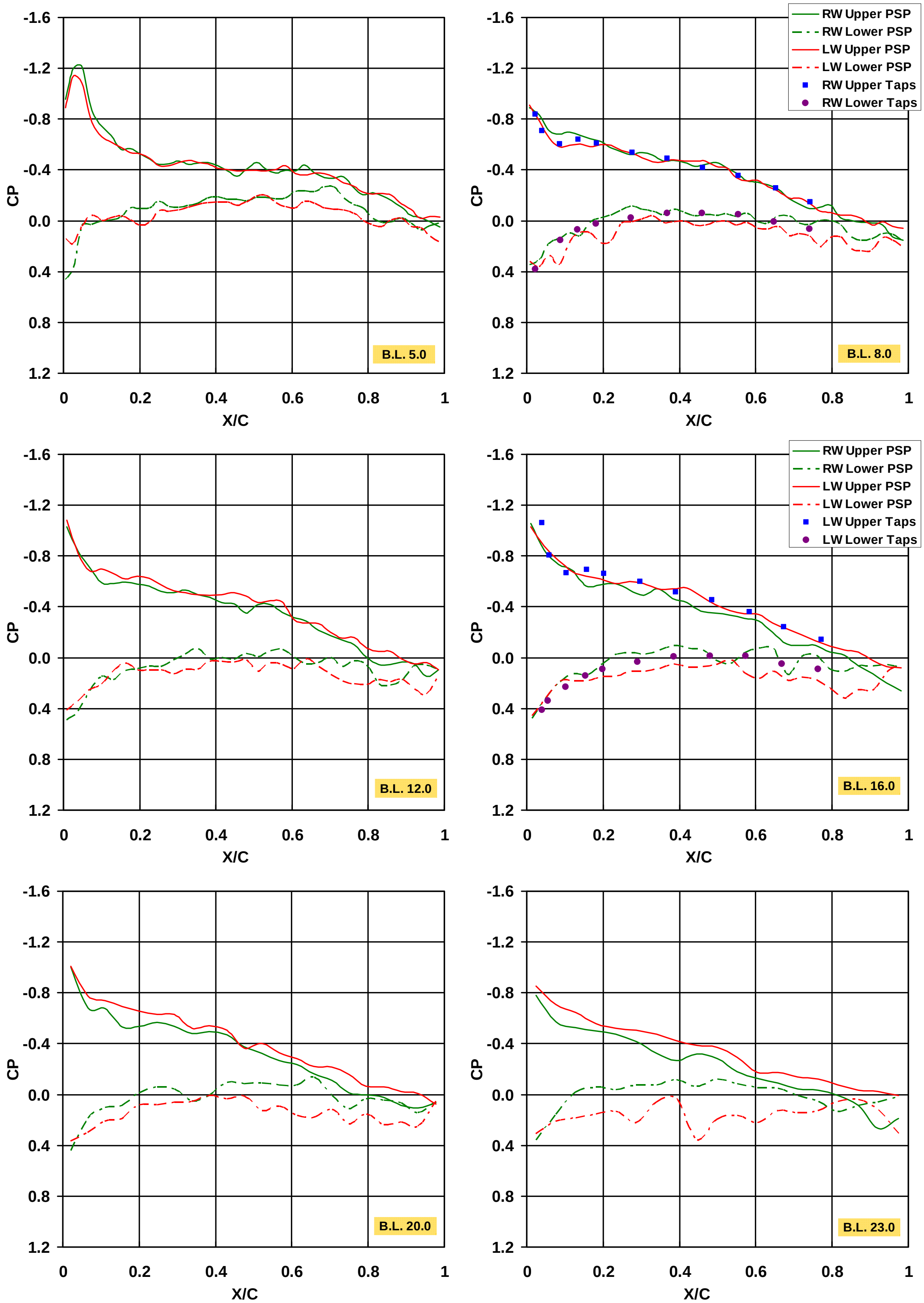
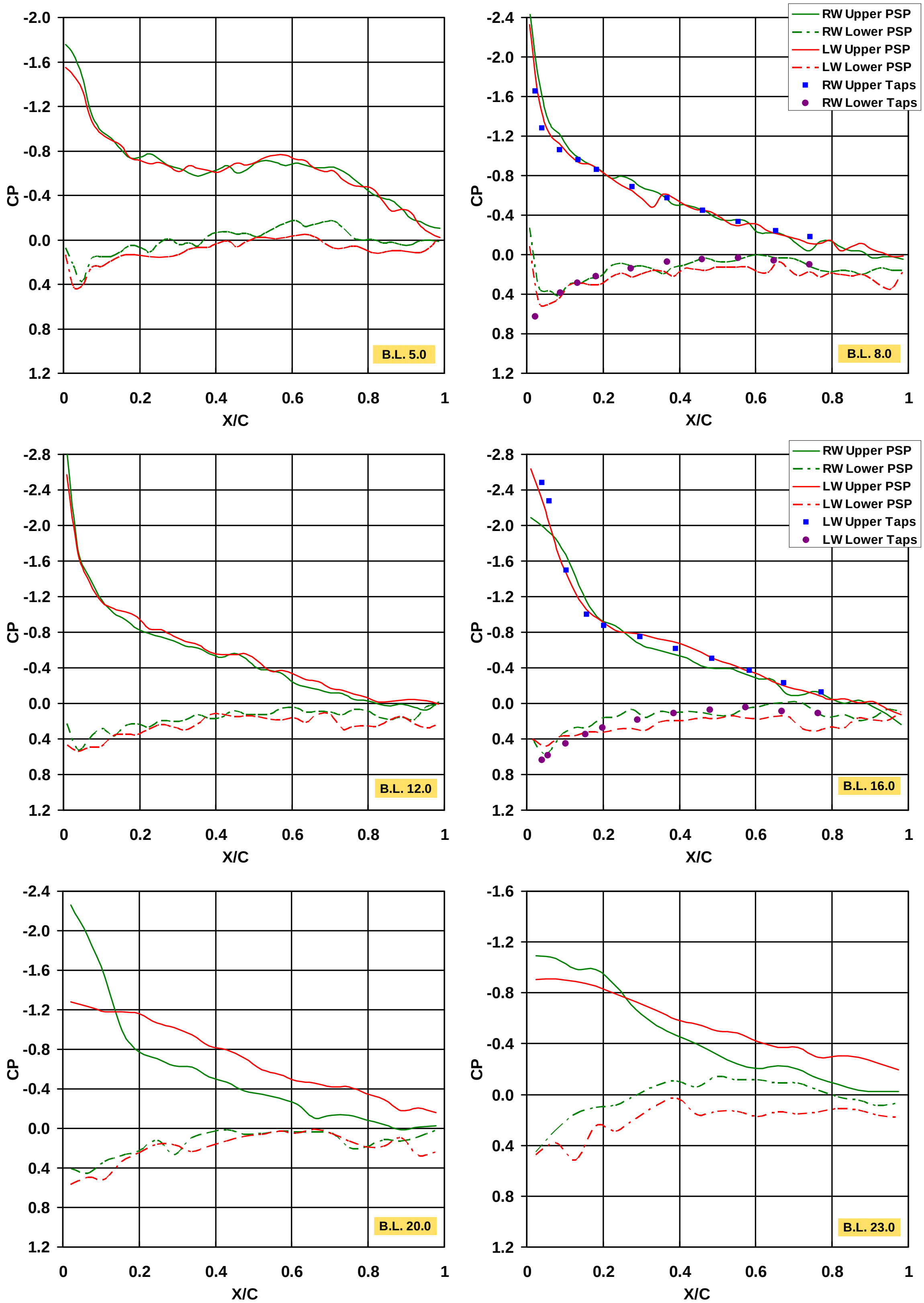
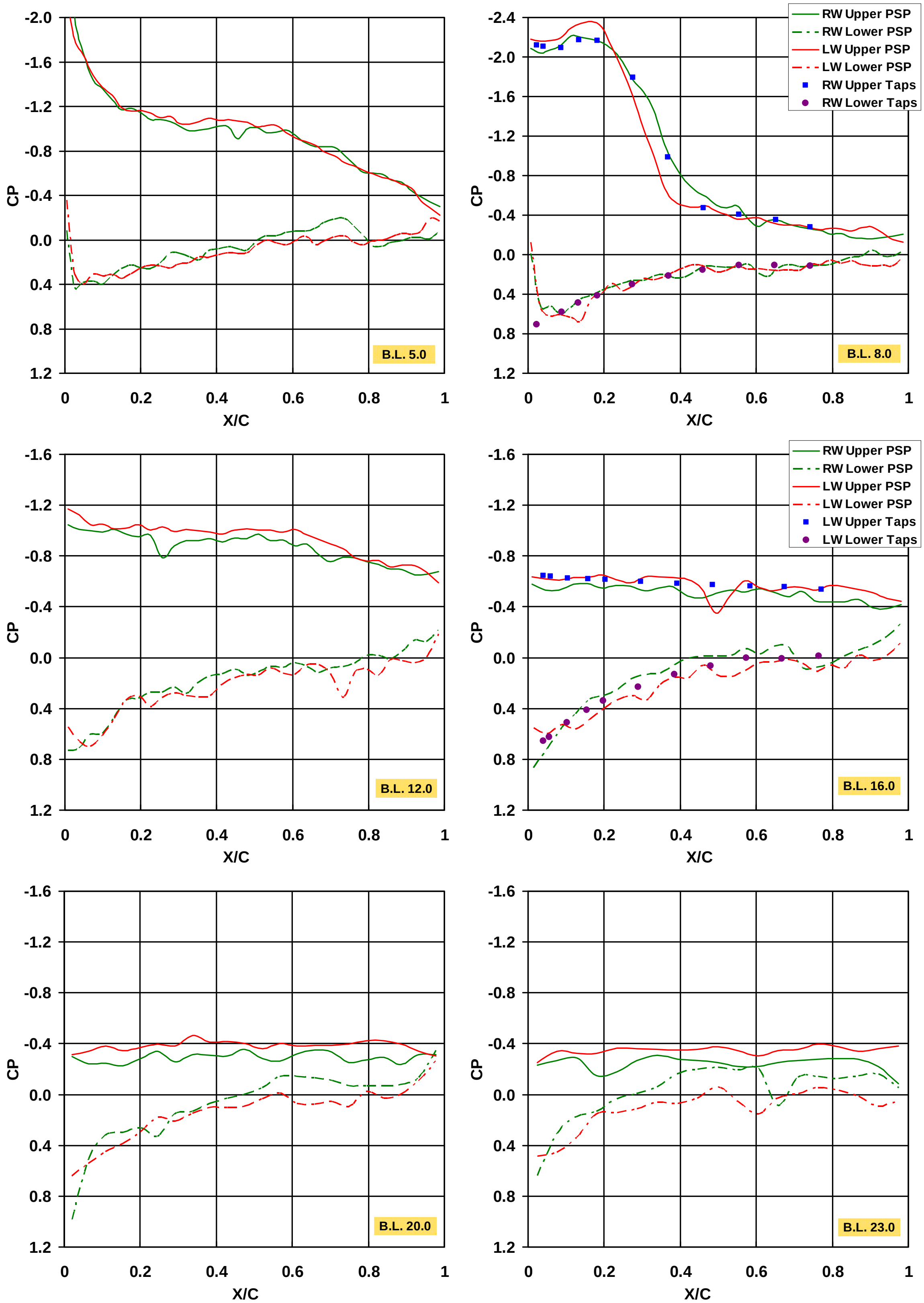


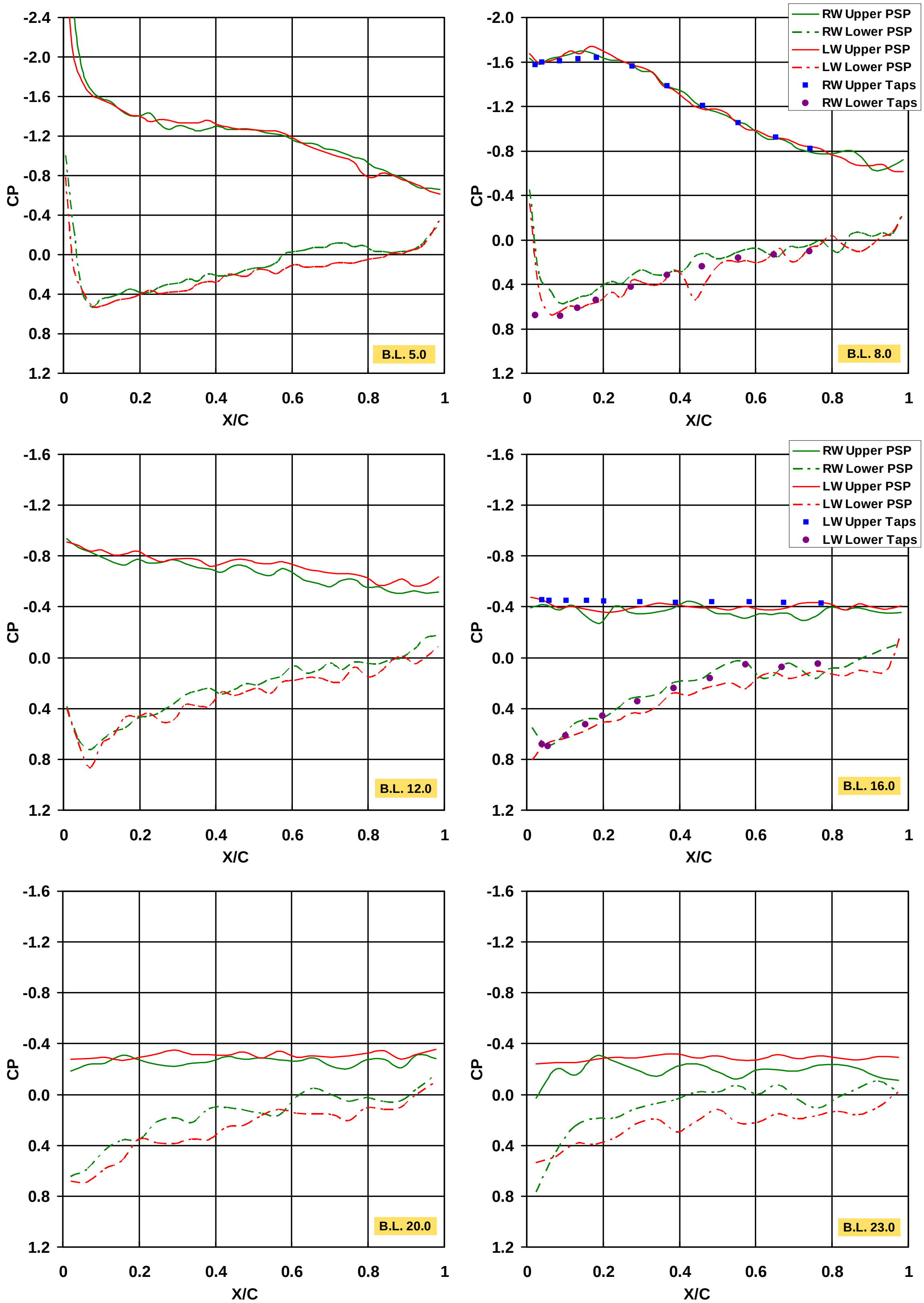
b. Alpha 4 deg.
Figure 8. Continued.



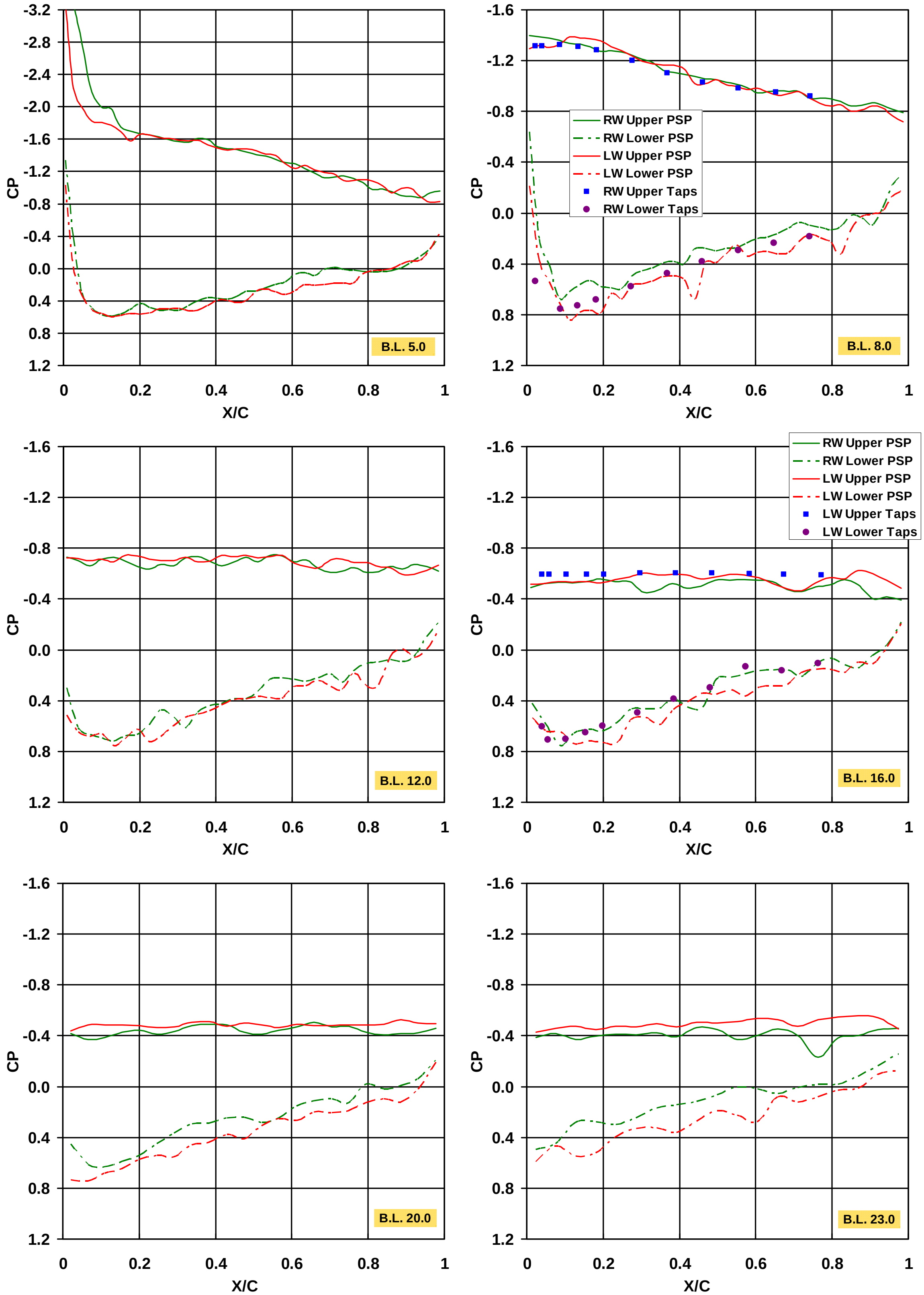
c. Alpha 8 deg.
Figure 8. Continued.



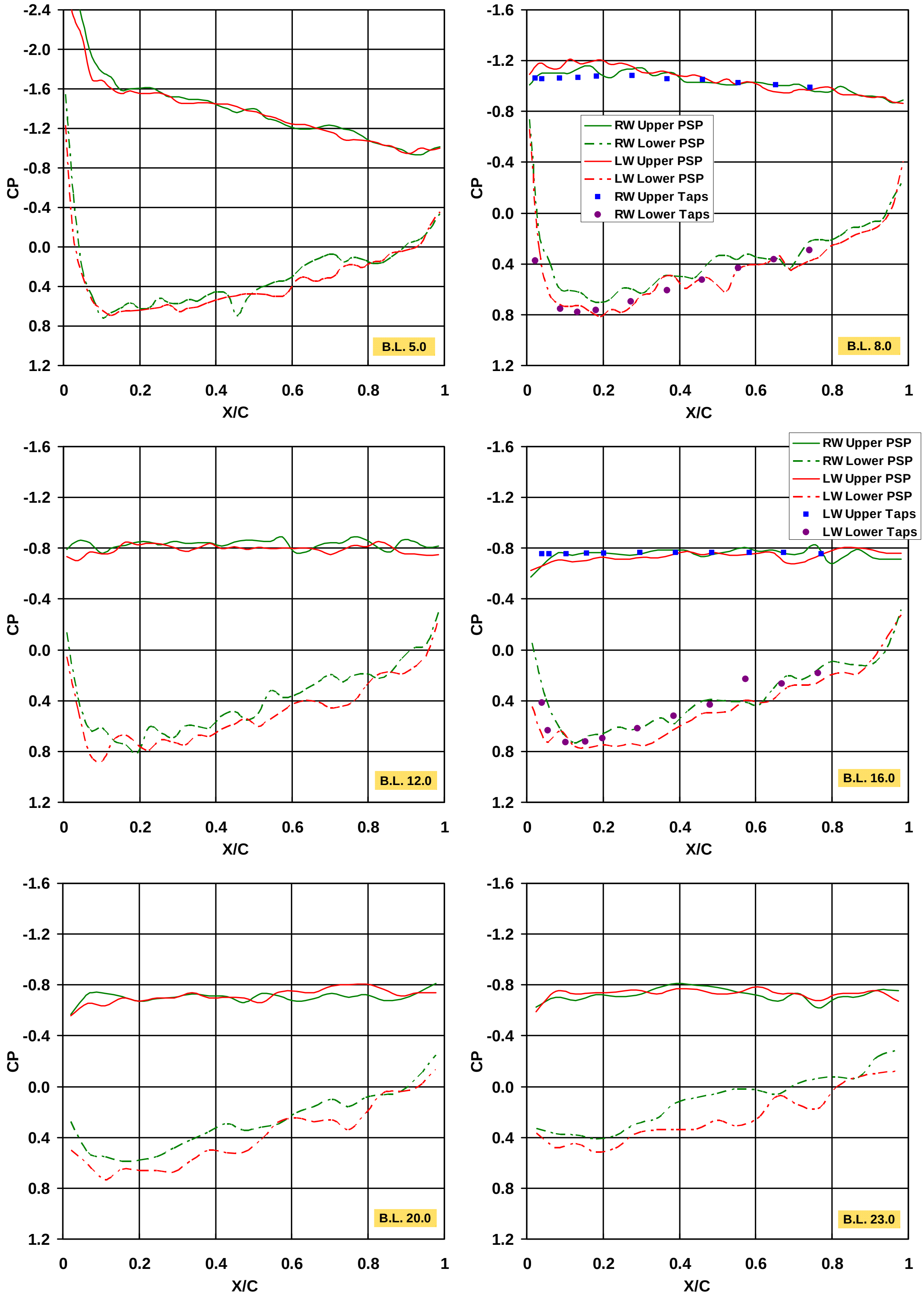
d. Alpha 14 deg.
Figure 8. Continued.



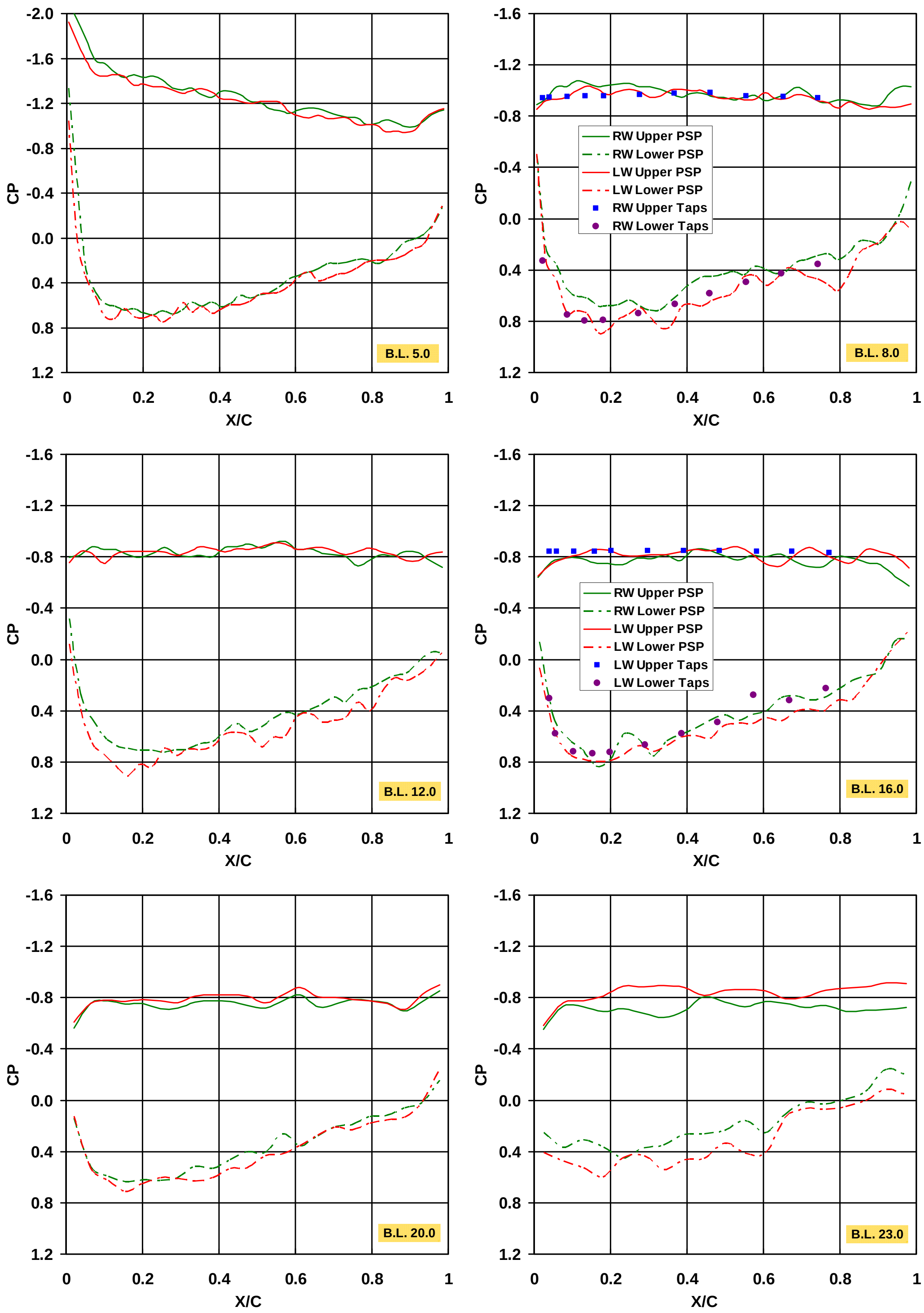
e. Alpha 20 deg.
Figure 8. Continued.



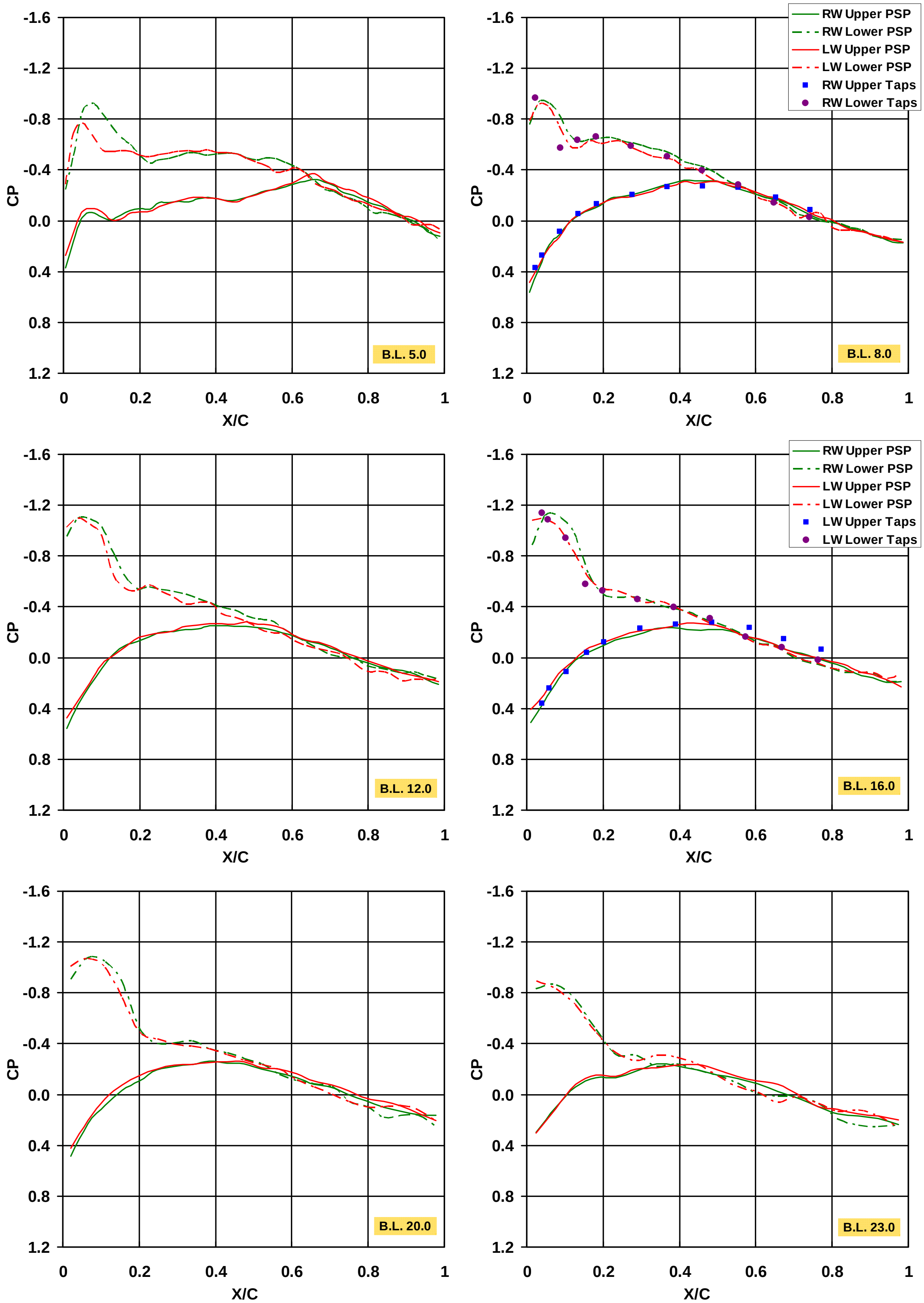
f. Alpha 28 deg.
Figure 8. Continued.



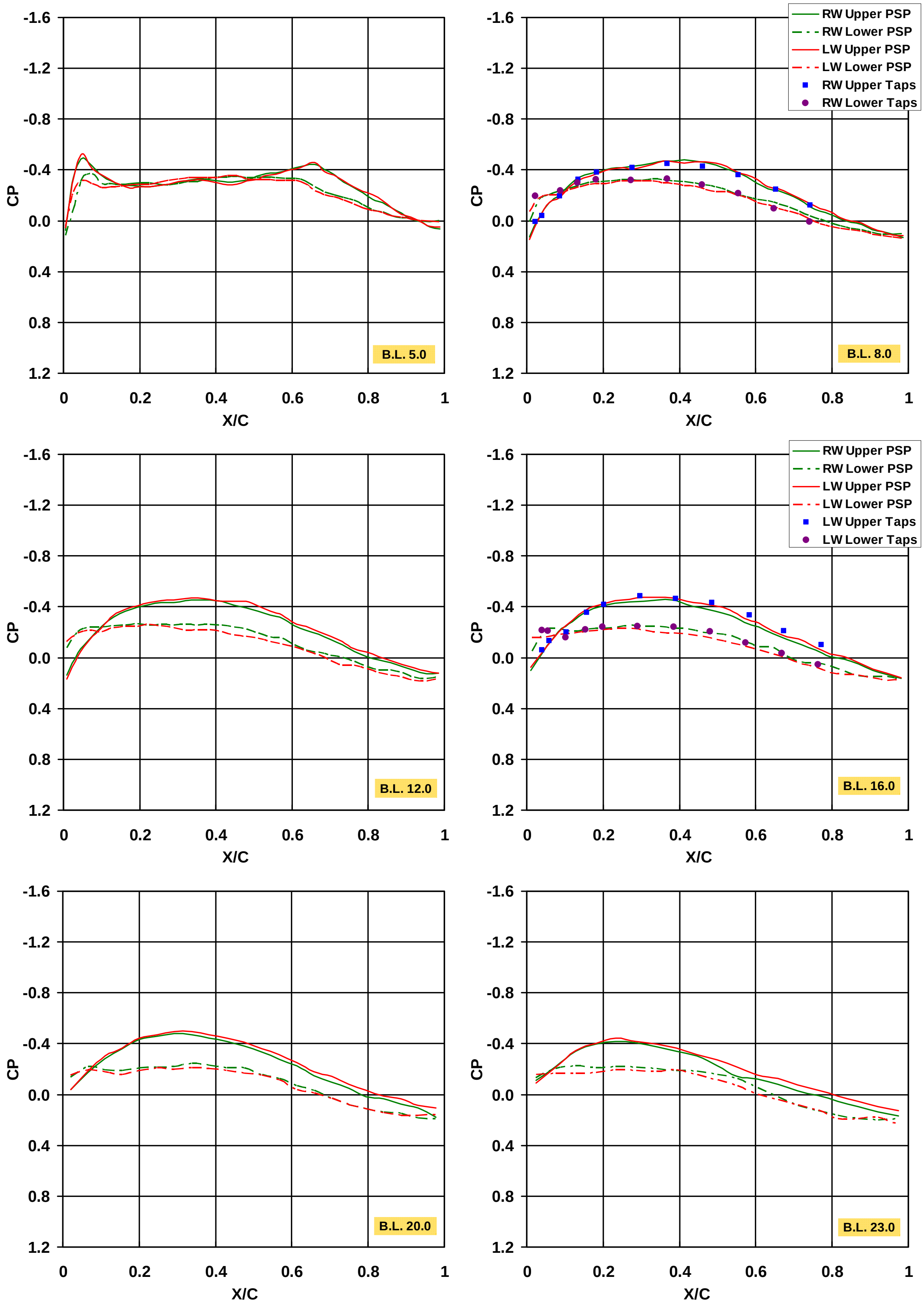
g. Alpha 36 deg.
Figure 8. Continued.



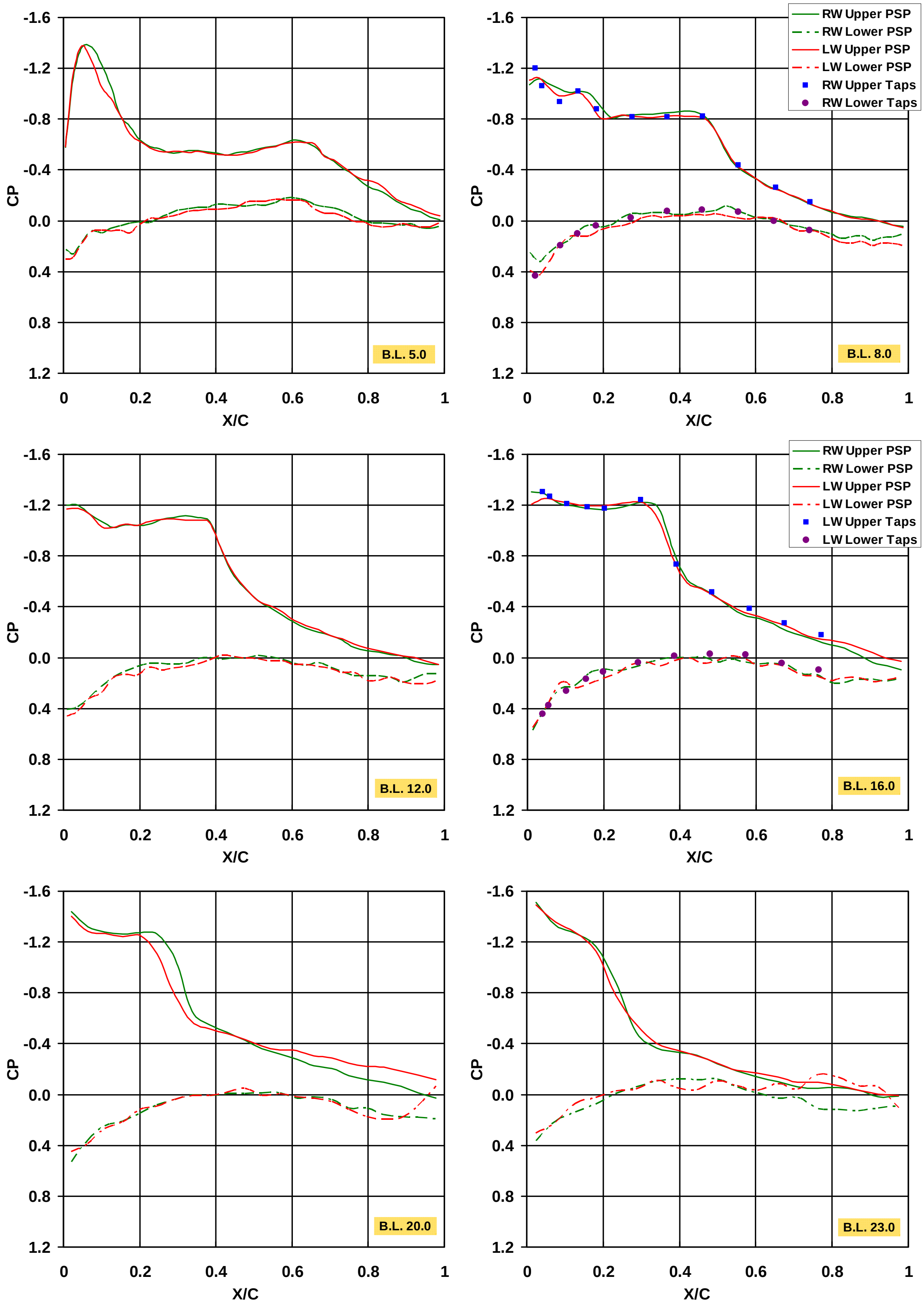
h. Alpha 40 deg.
Figure 8. Concluded.



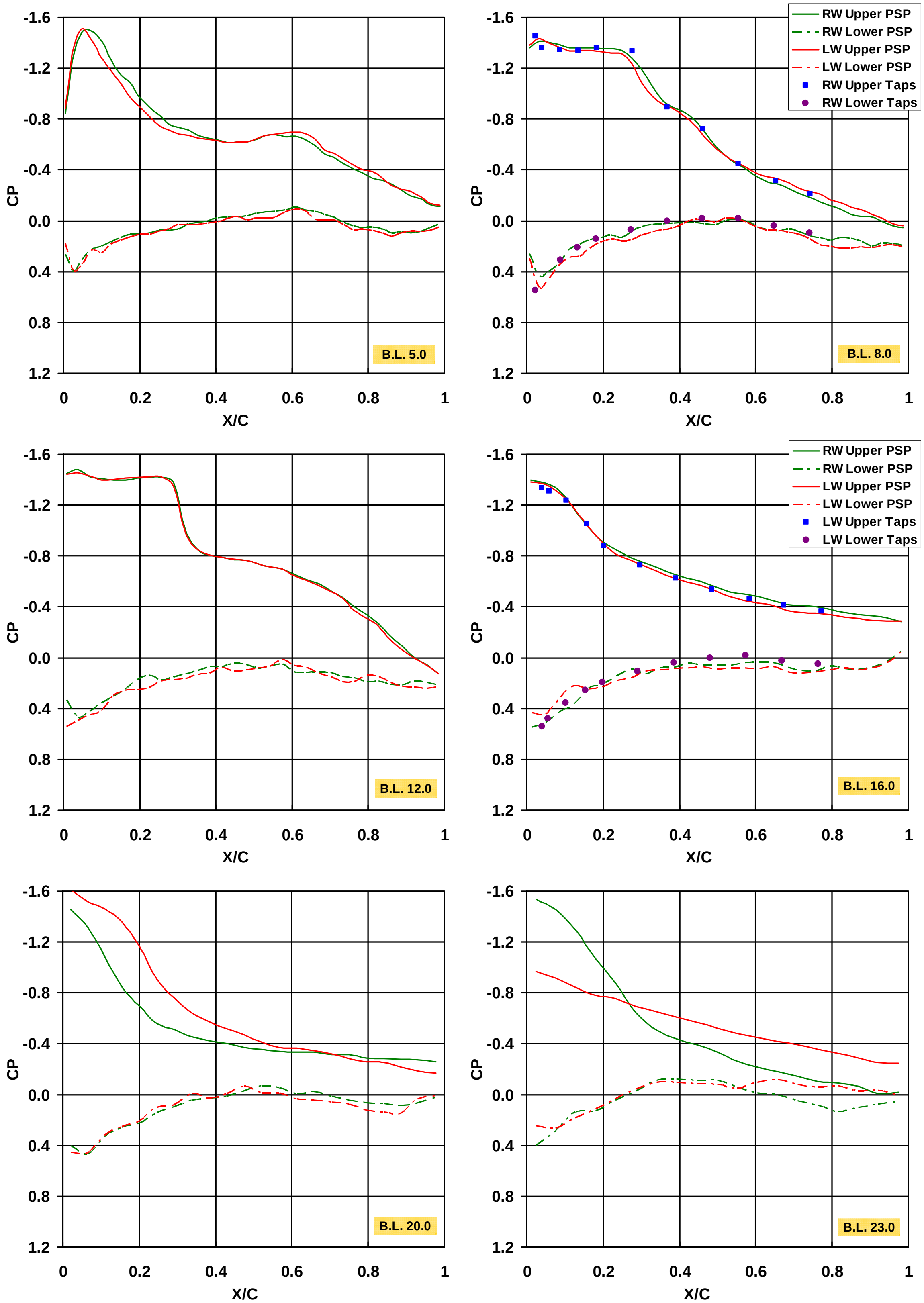
a. Alpha -3 deg.
Figure 9. Mach Number 0.8 Wing Pressure Coefficient Comparison.



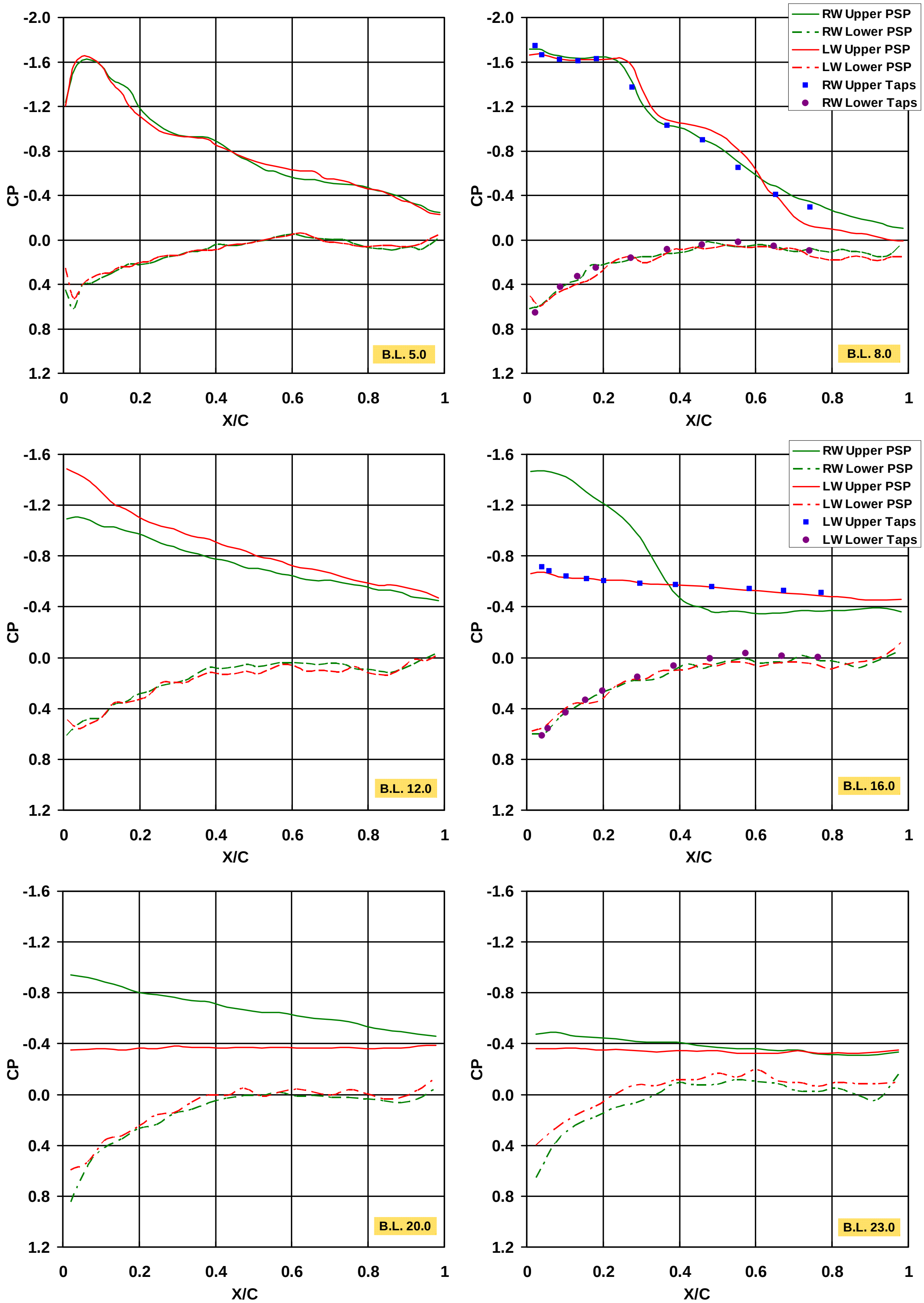
b. Alpha 0 deg.
Figure 8. Continued.



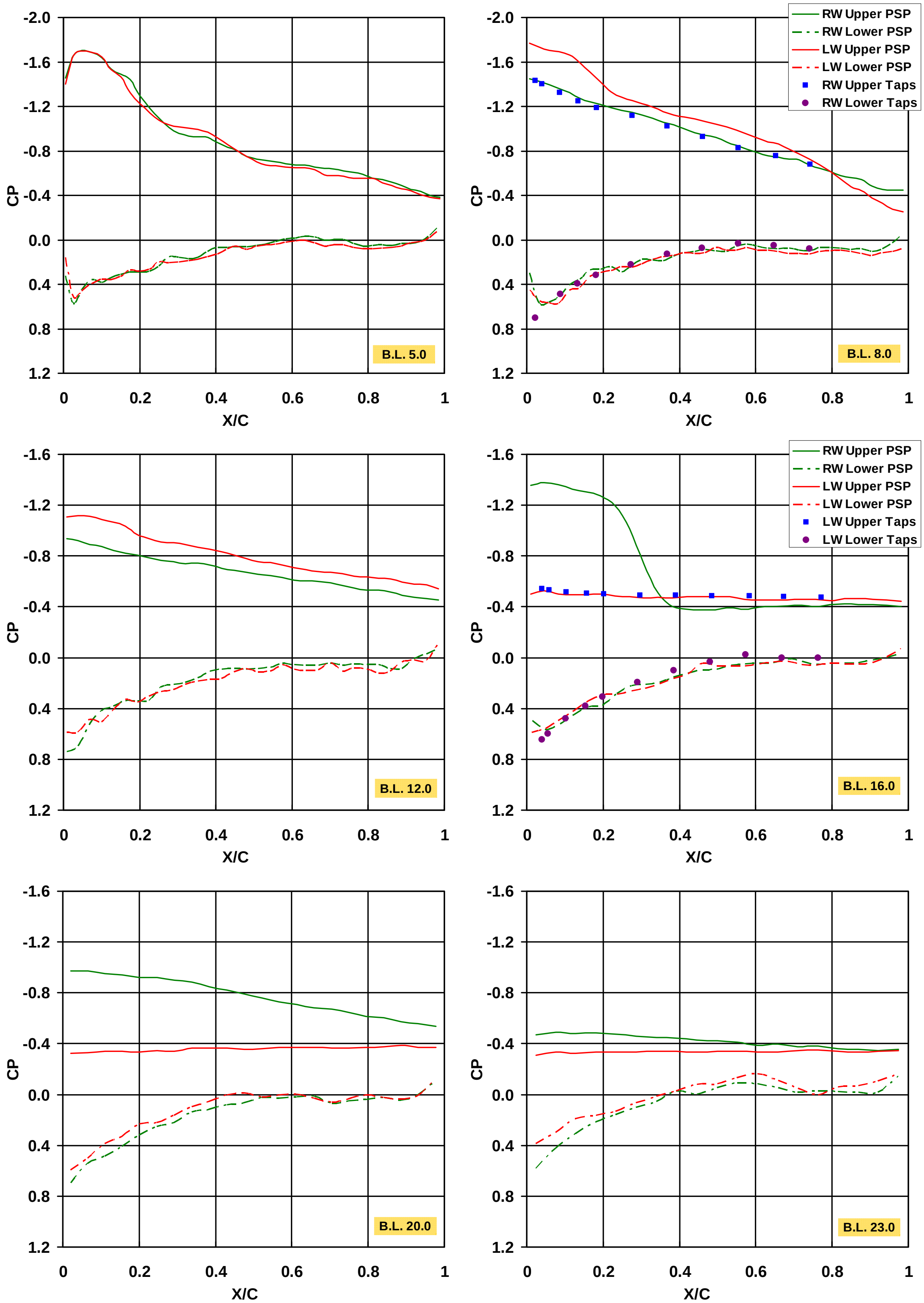
c. Alpha 5 deg.
Figure 9. Continued.



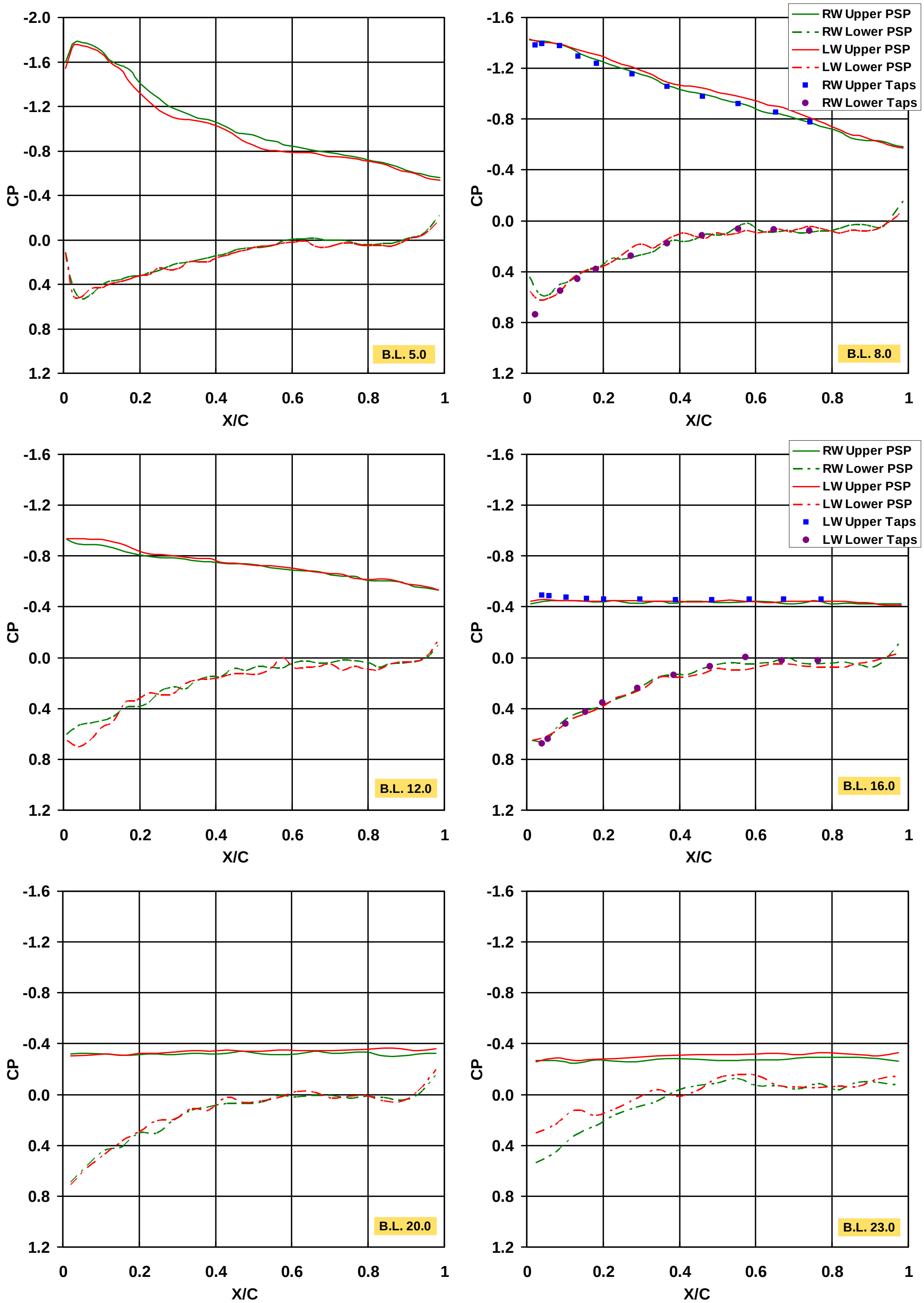
d. Alpha 7 deg.
Figure 9. Continued.



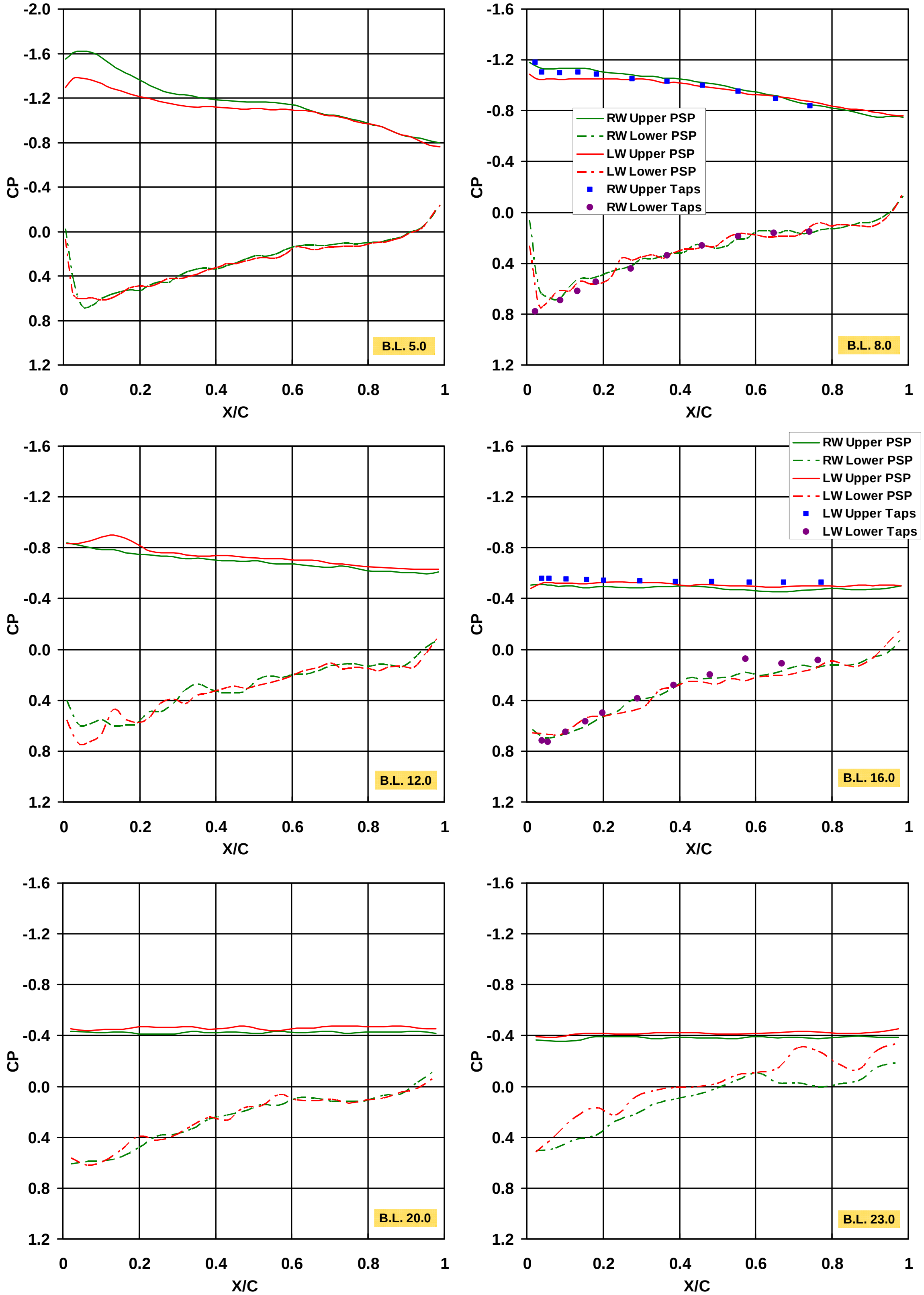
e. Alpha 10 deg.
Figure 9. Continued.



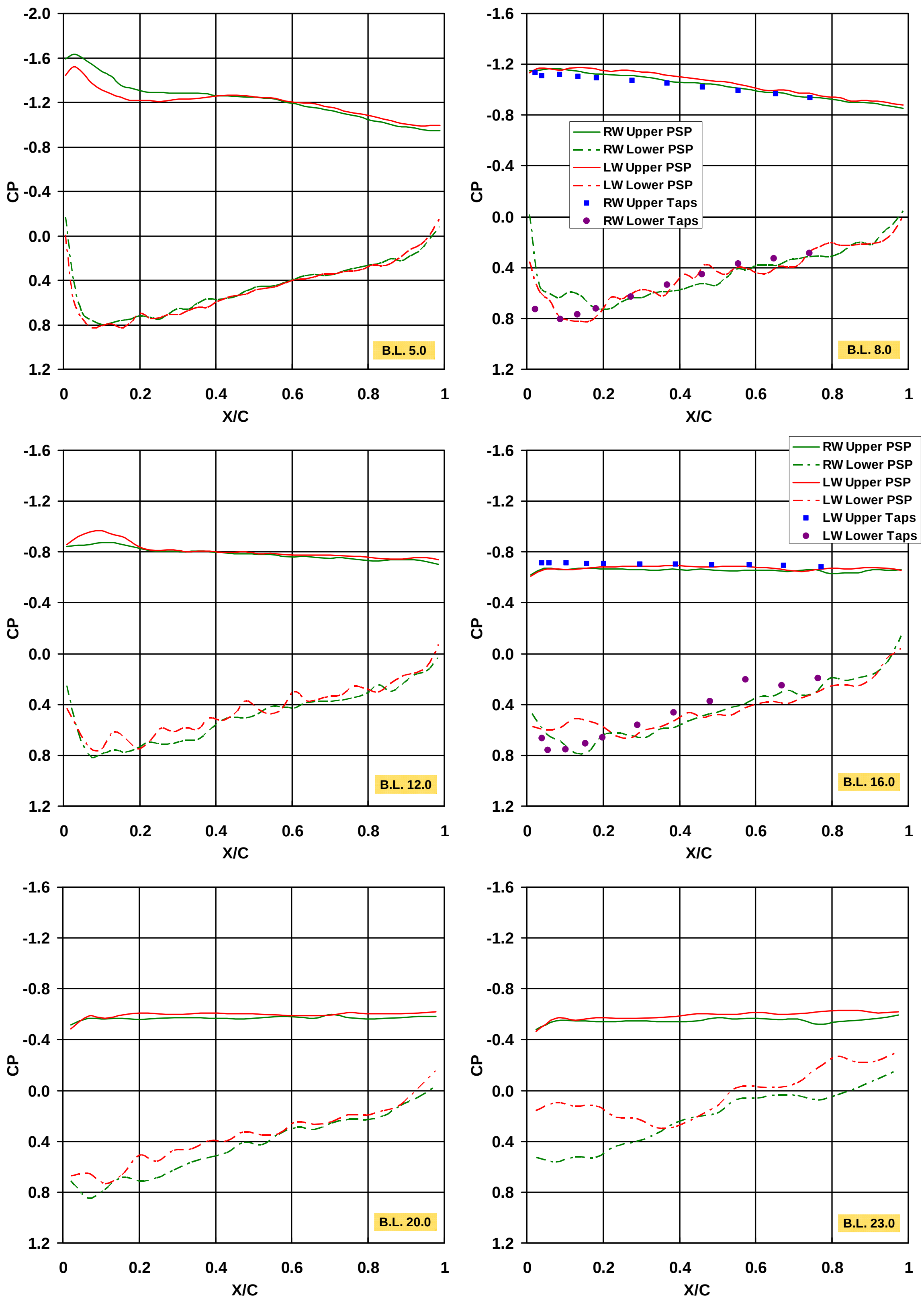
f. Alpha 12 deg.
Figure 9. Continued.



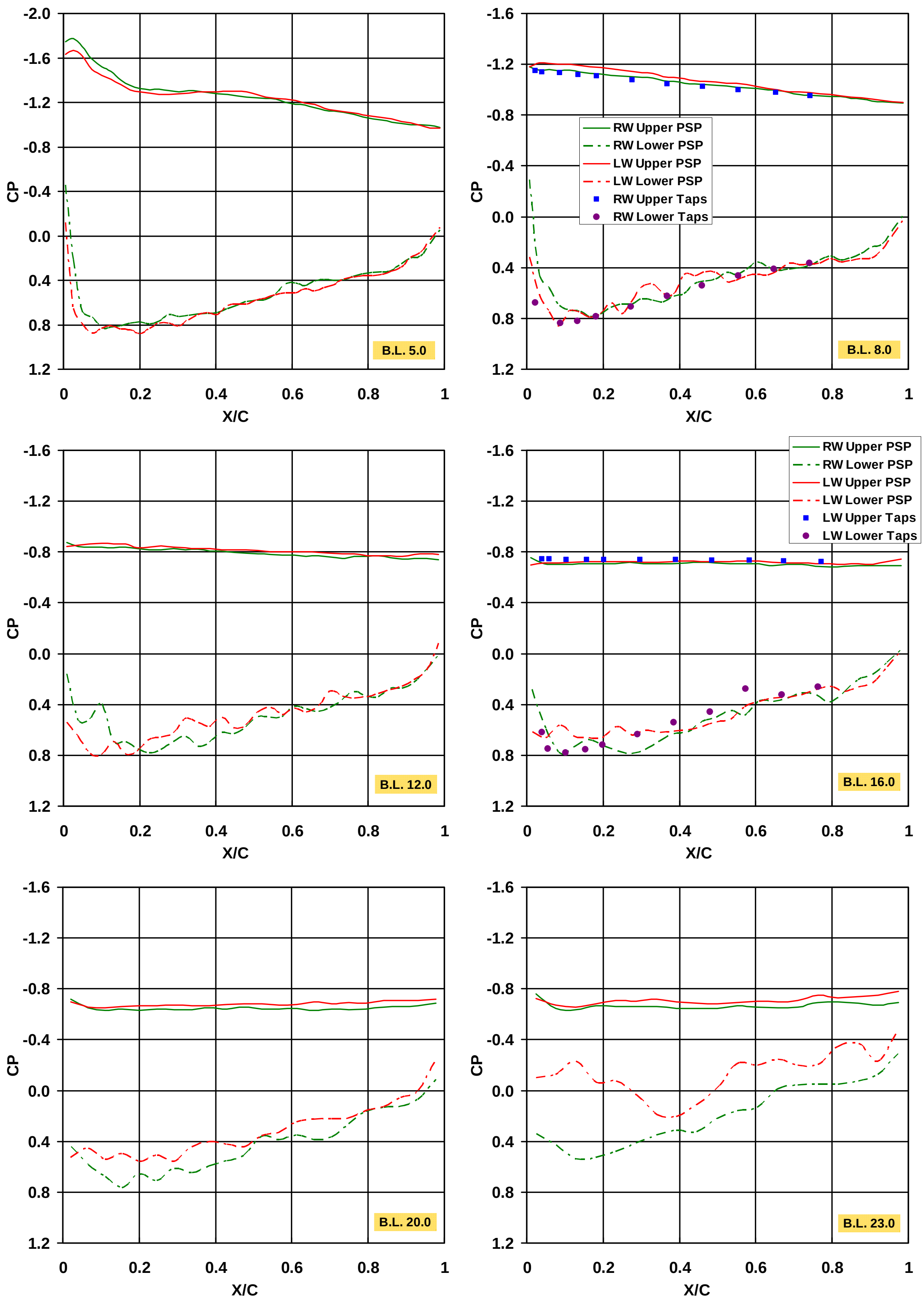
g. Alpha 14 deg.
Figure 9. Continued.



h. Alpha 20 deg.
Figure 9. Continued.



i. Alpha 28 deg.
Figure 9. Continued.



j. Alpha 32 deg.
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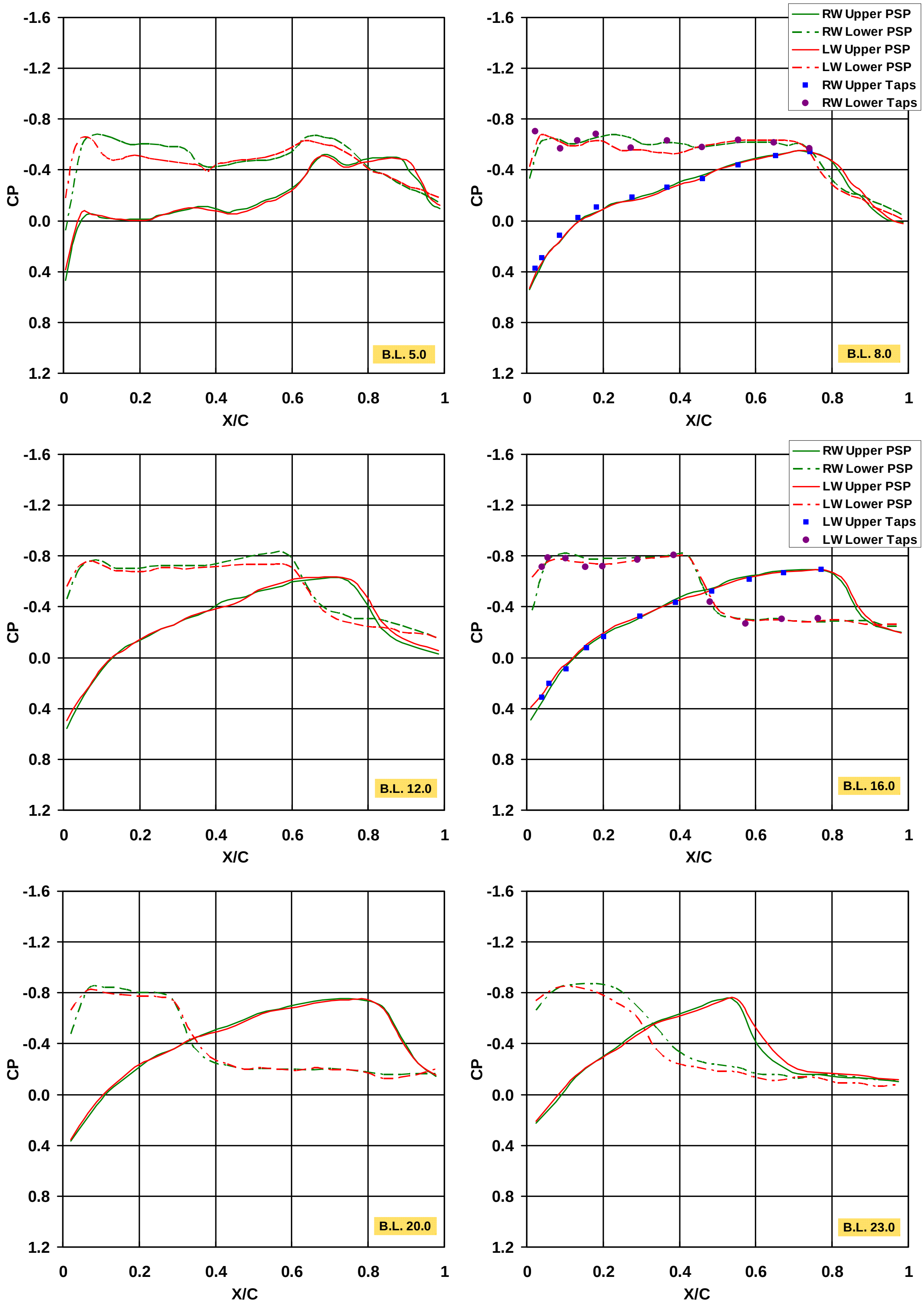
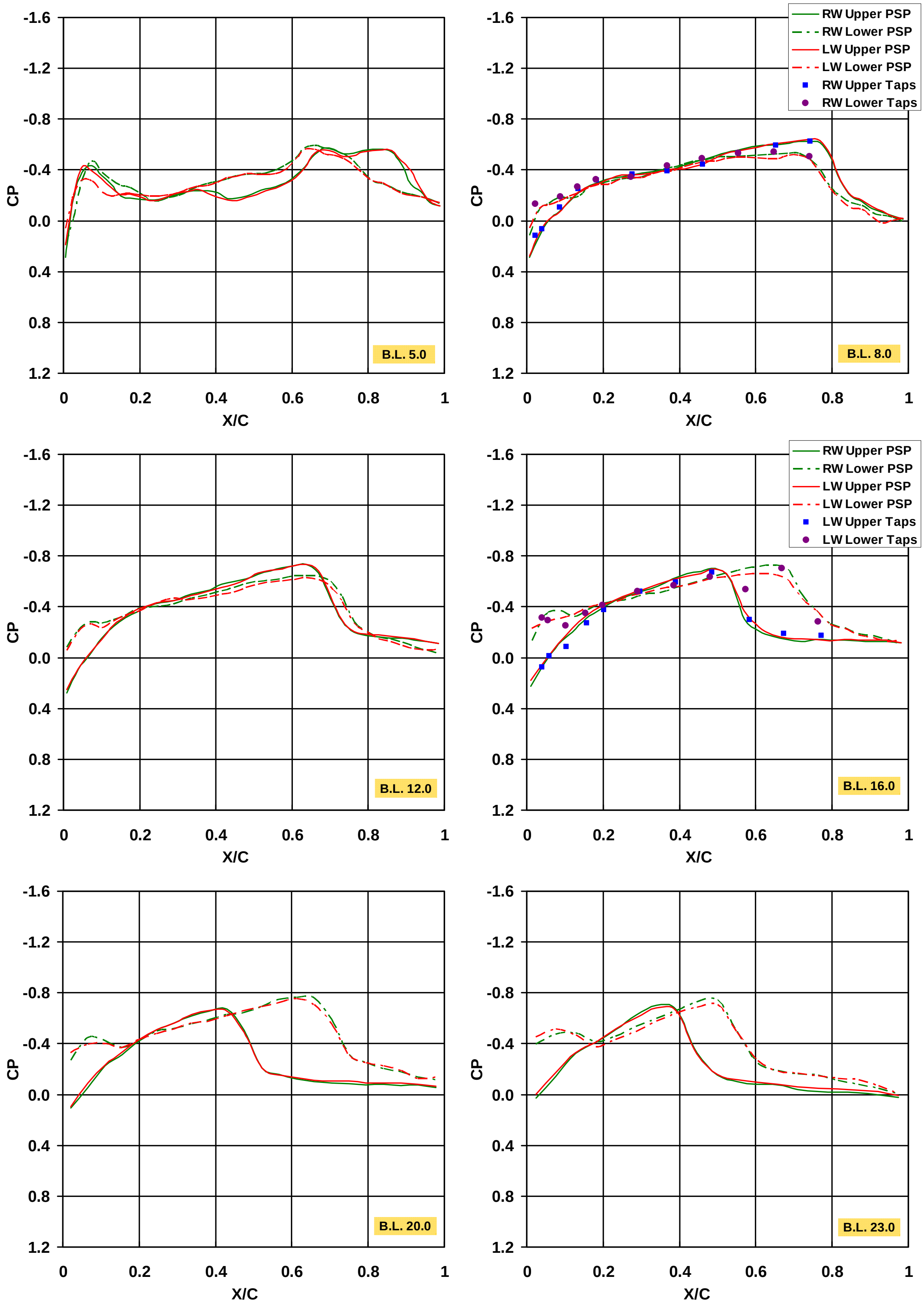
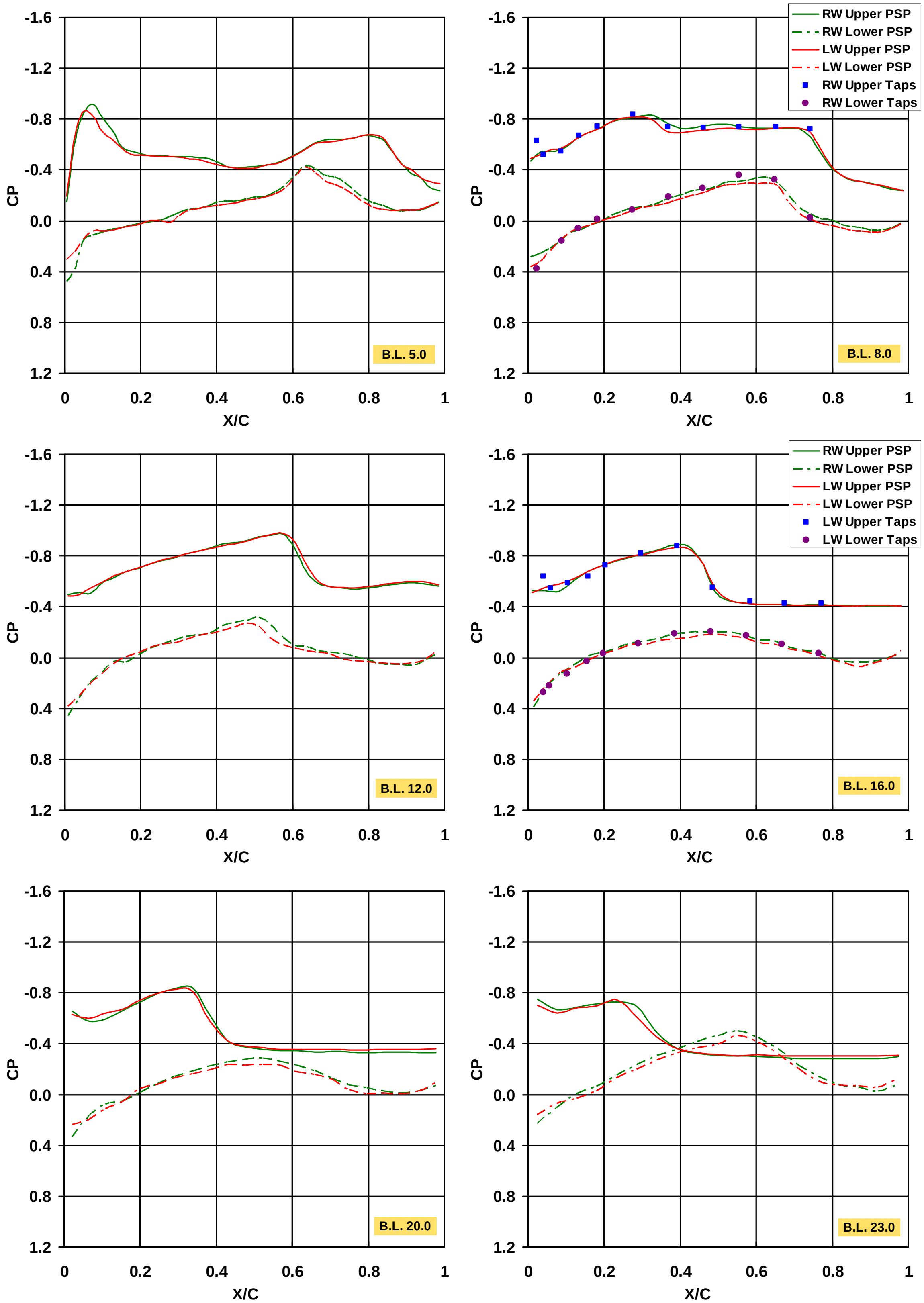


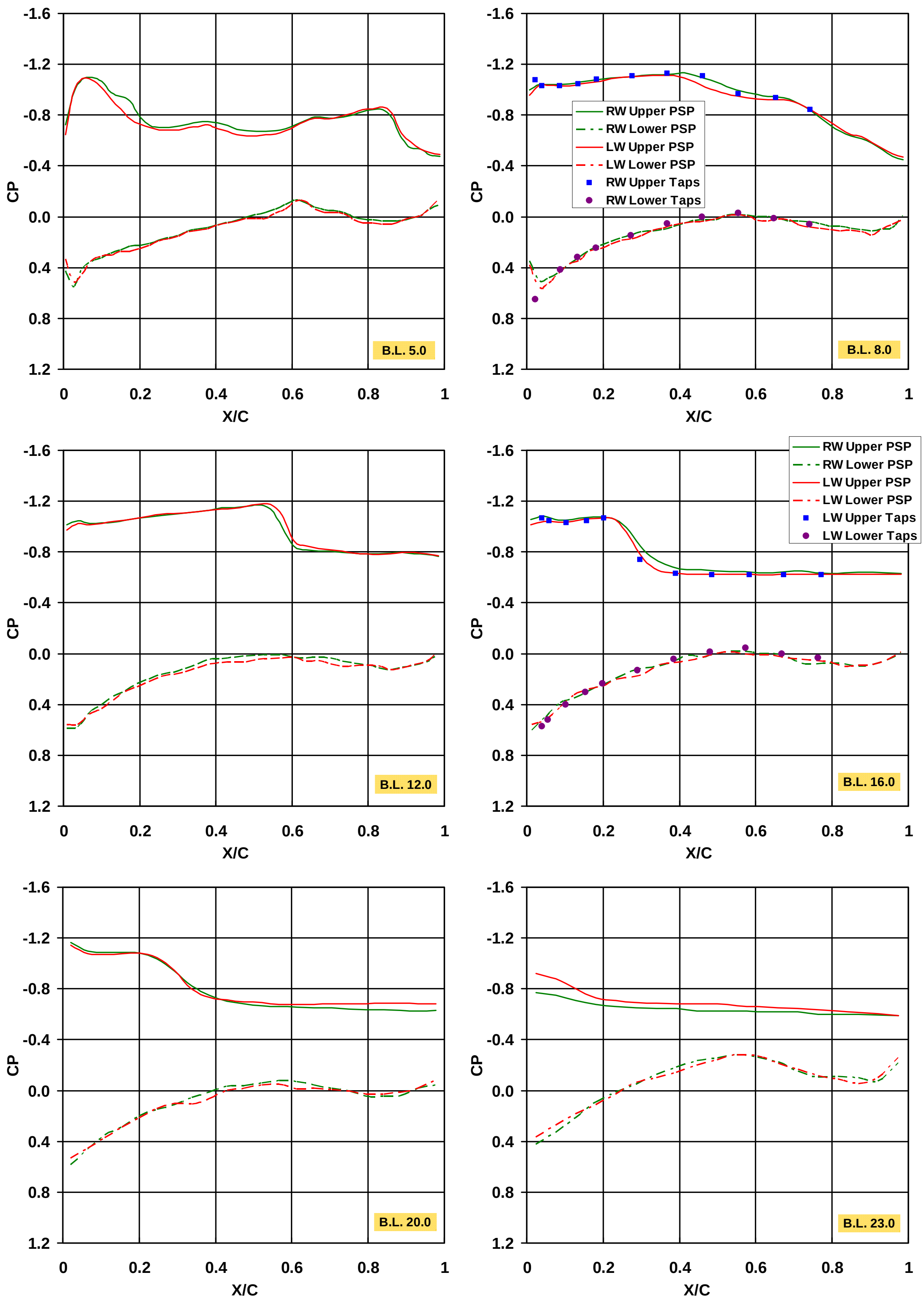
a. Alpha -3 deg.
Figure 10. Mach Number 0.95 Wing Pressure Coefficient Comparison.



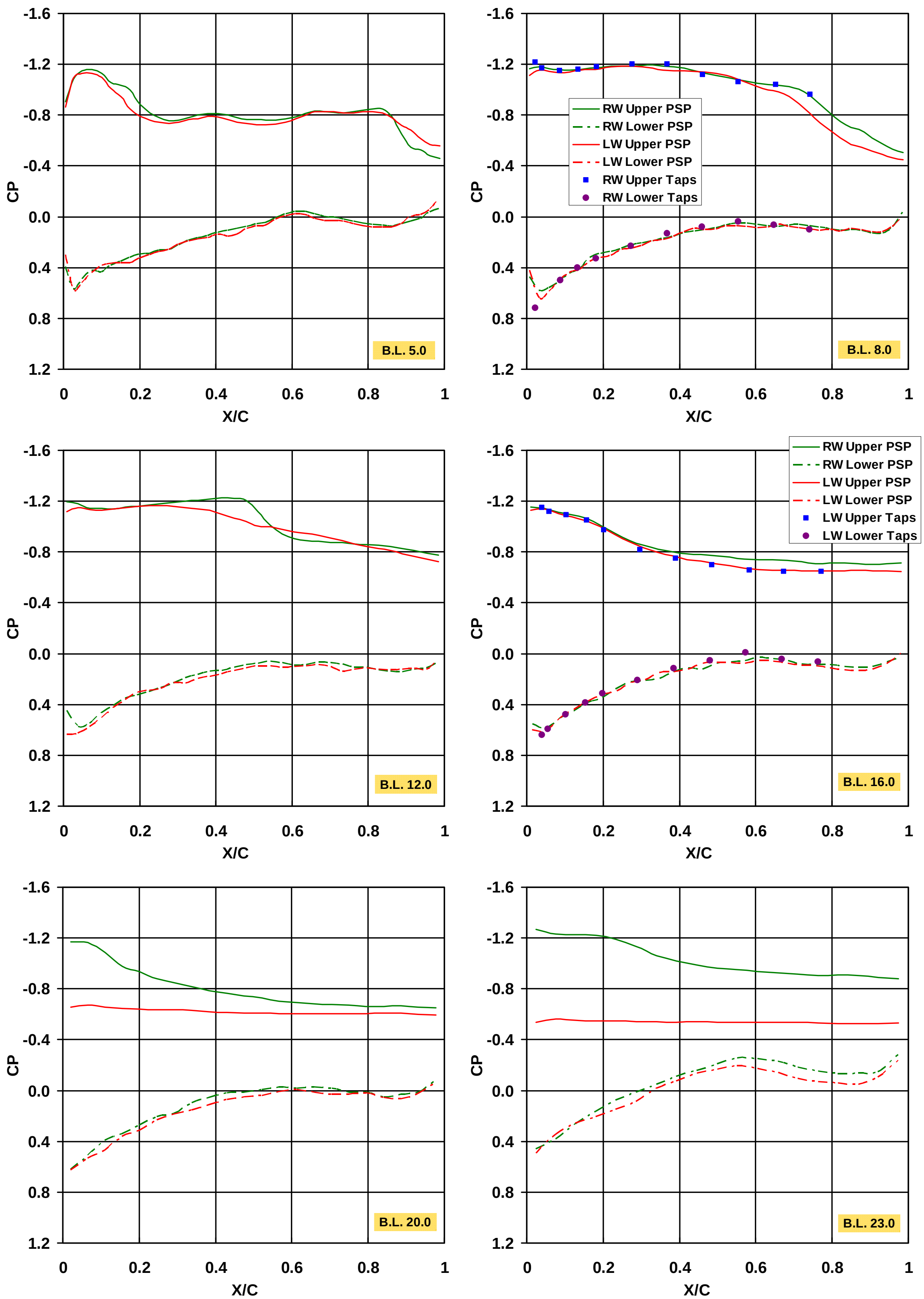
b. Alpha 0 deg.
Figure 10. Continued.



c. Alpha 5 deg.
Figure 10. Continued.



d. Alpha 10 deg.
Figure 10. Continued.



e. Alpha 12 deg.
Figure 10. Continued.

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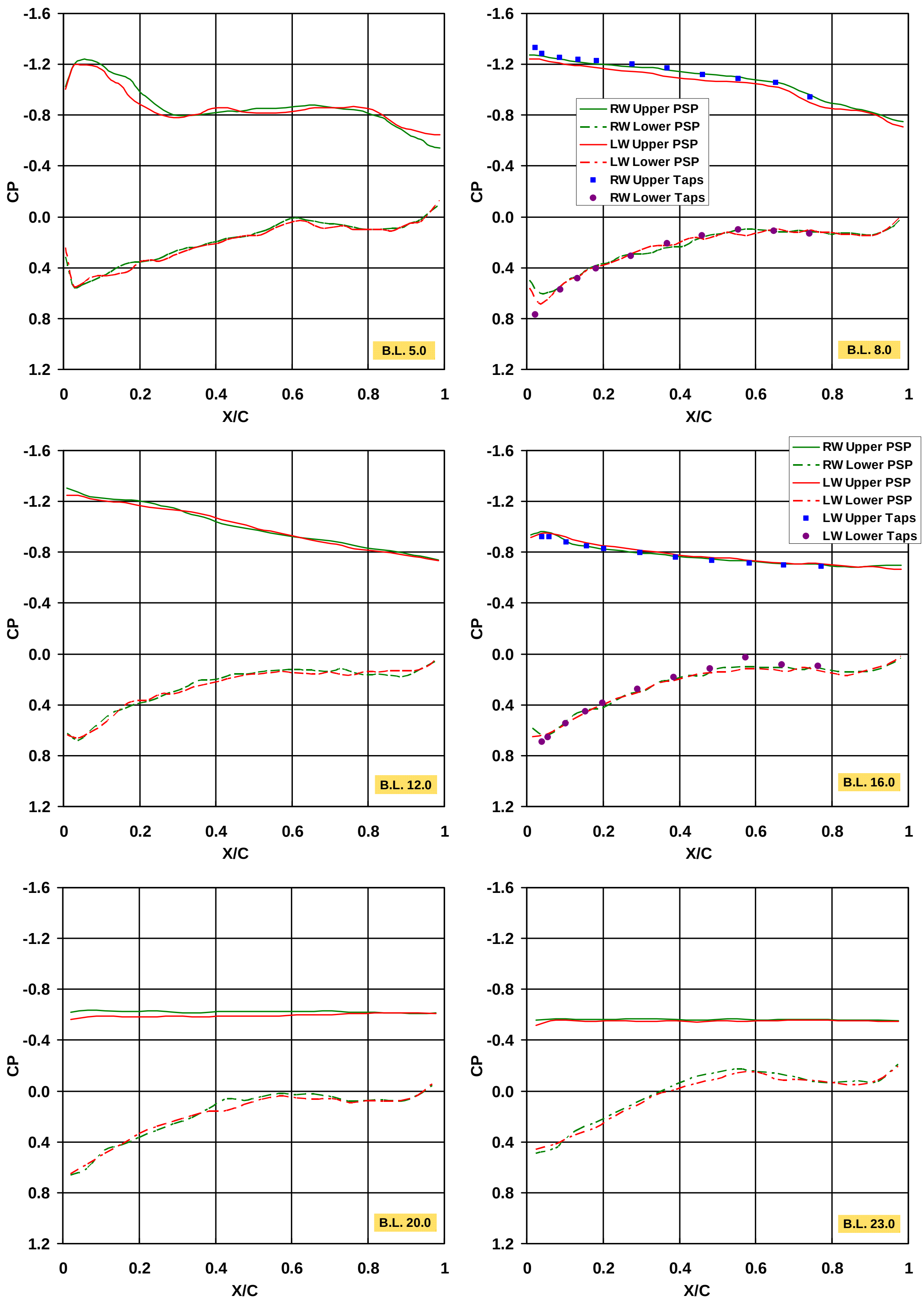
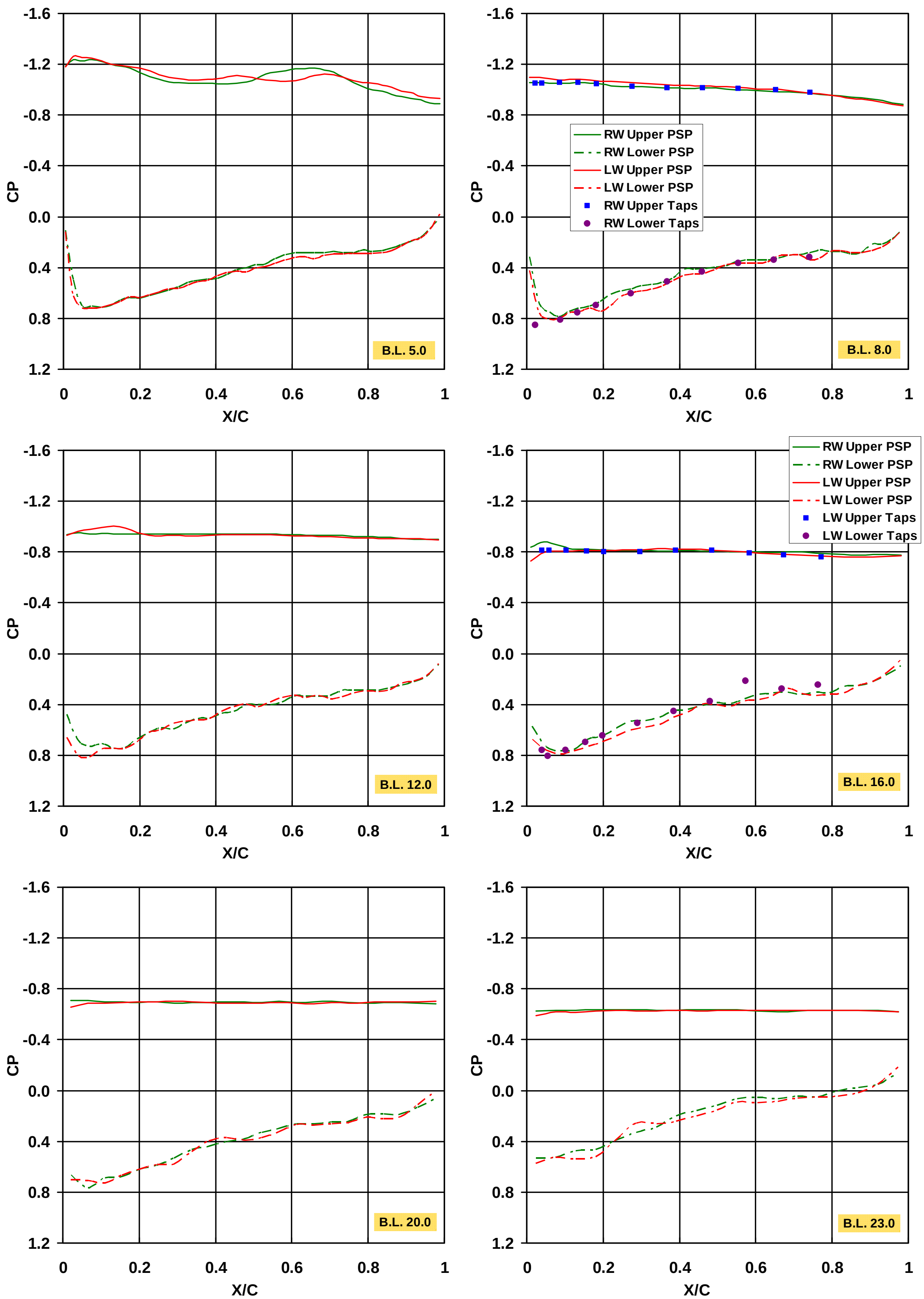
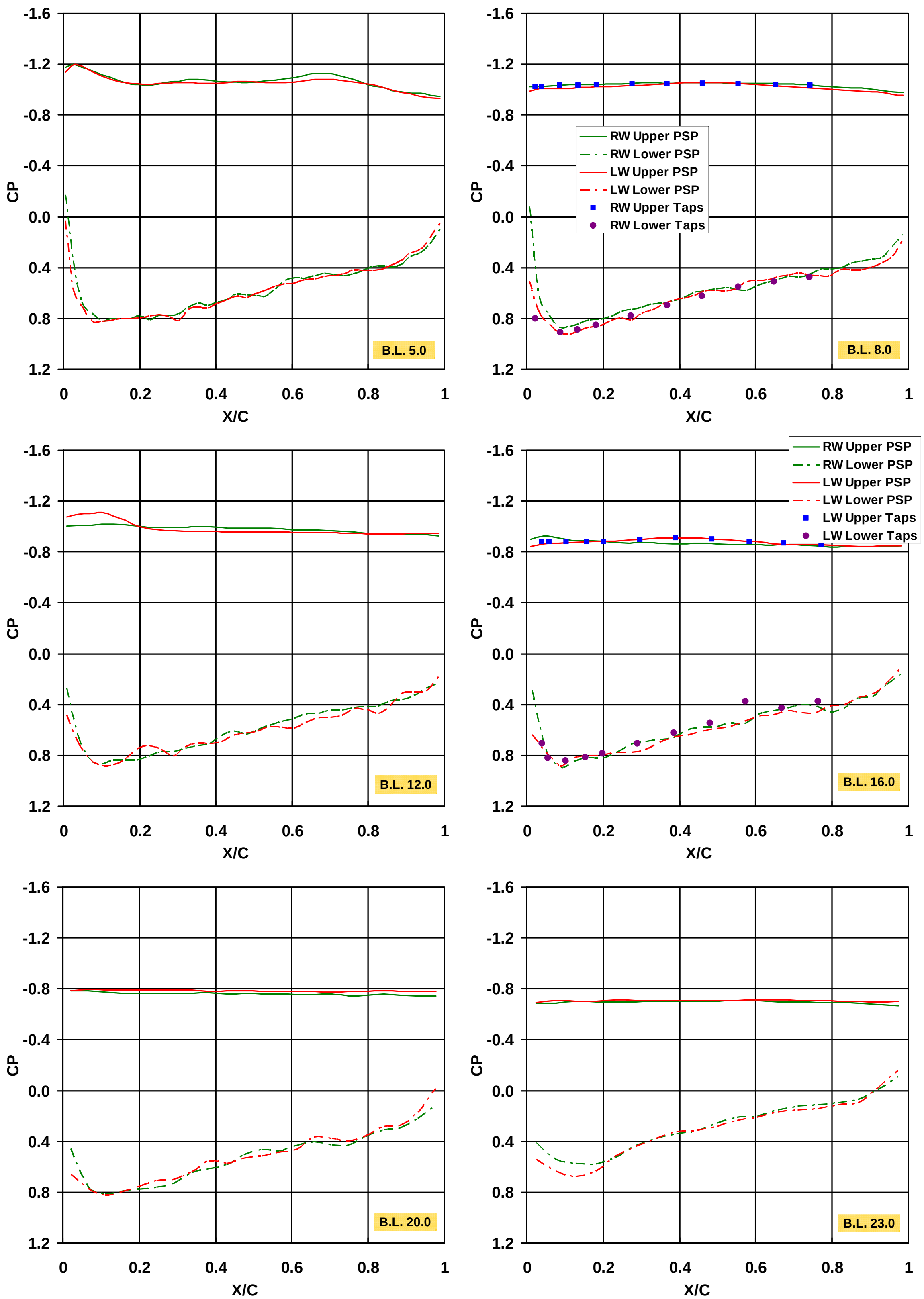


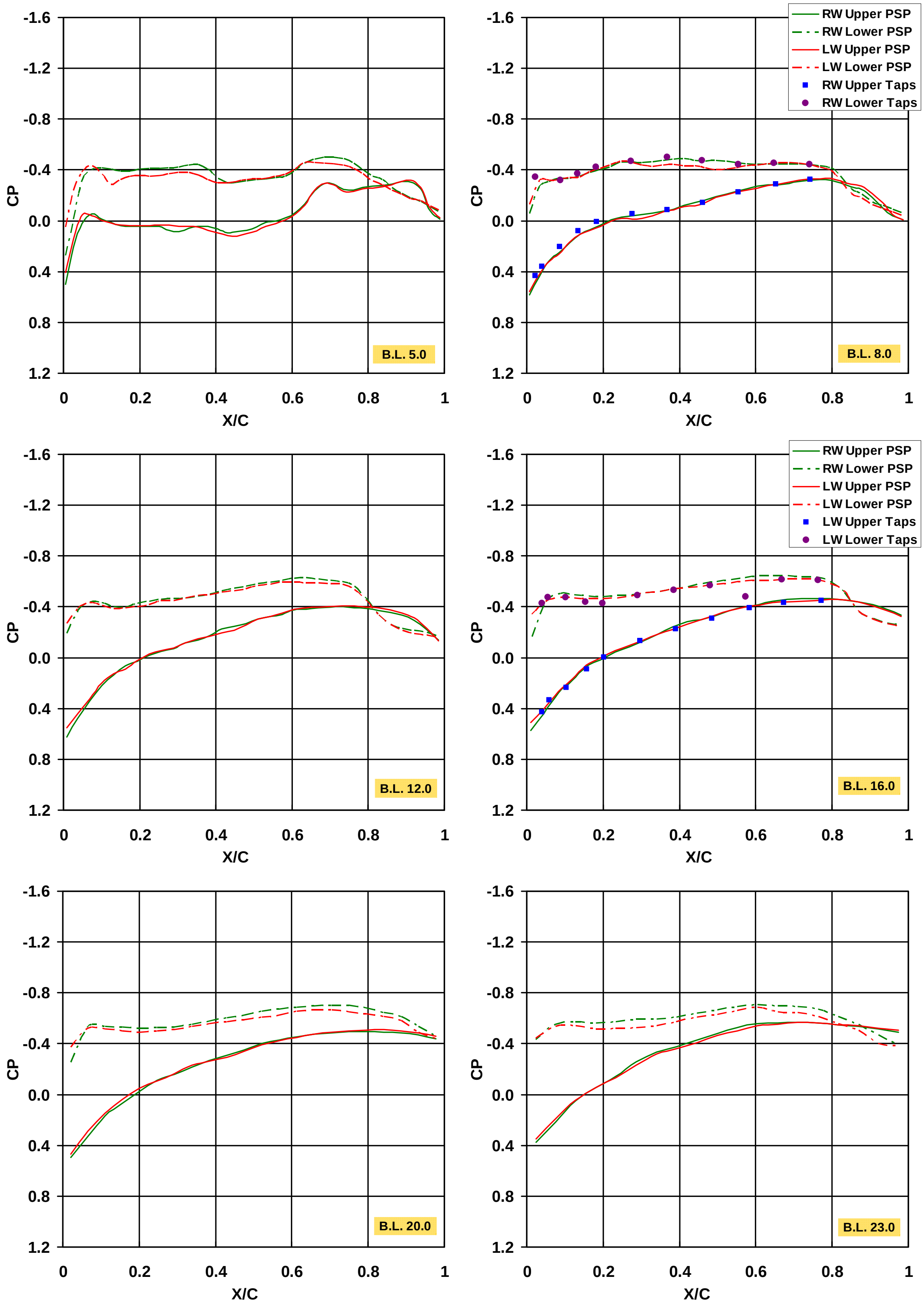
f. Alpha 14 deg.
Figure 10. Continued.



g. Alpha 24 deg.
Figure 10. Continued.

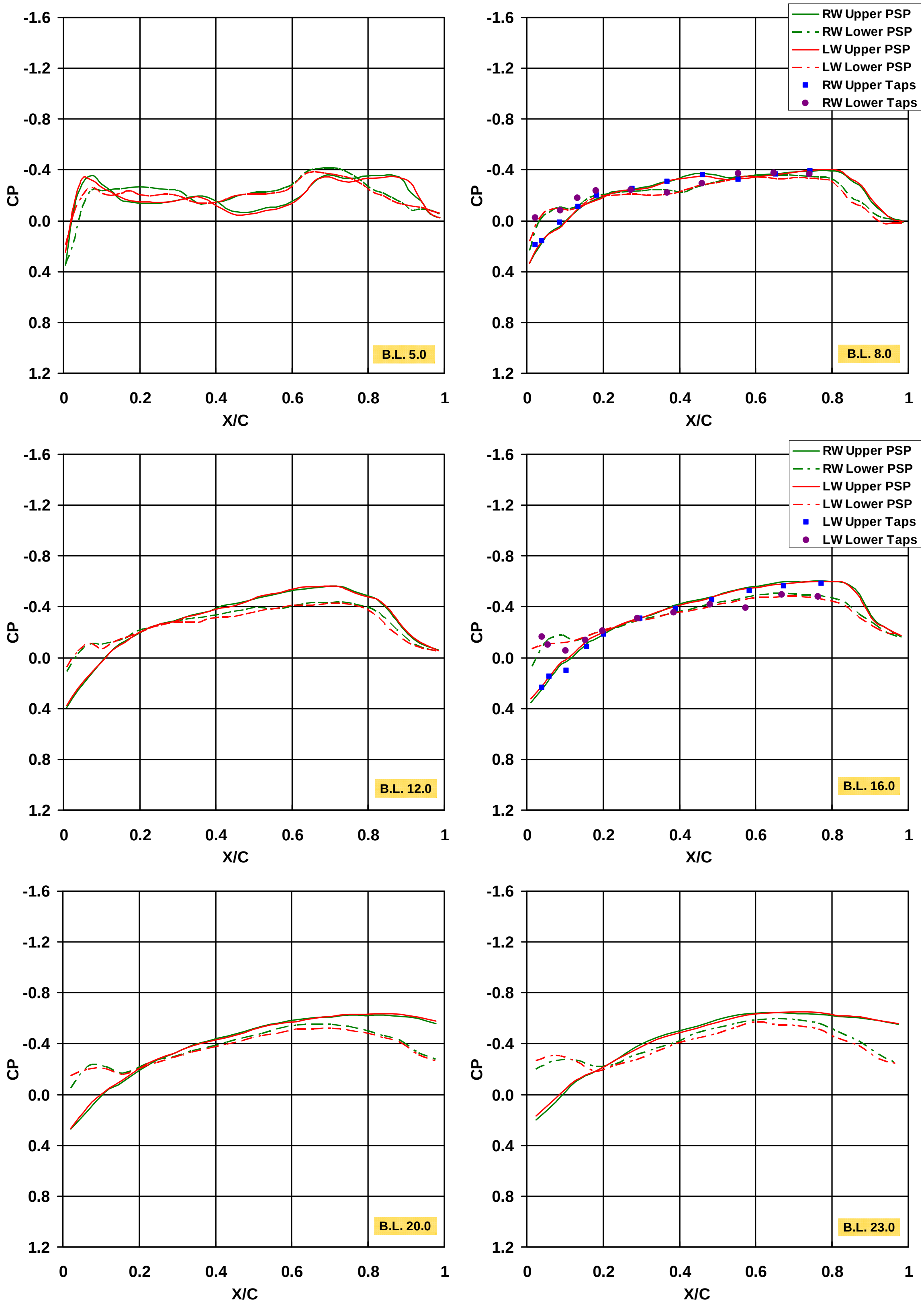


h. Alpha 32 deg.
Figure 10. Concluded.

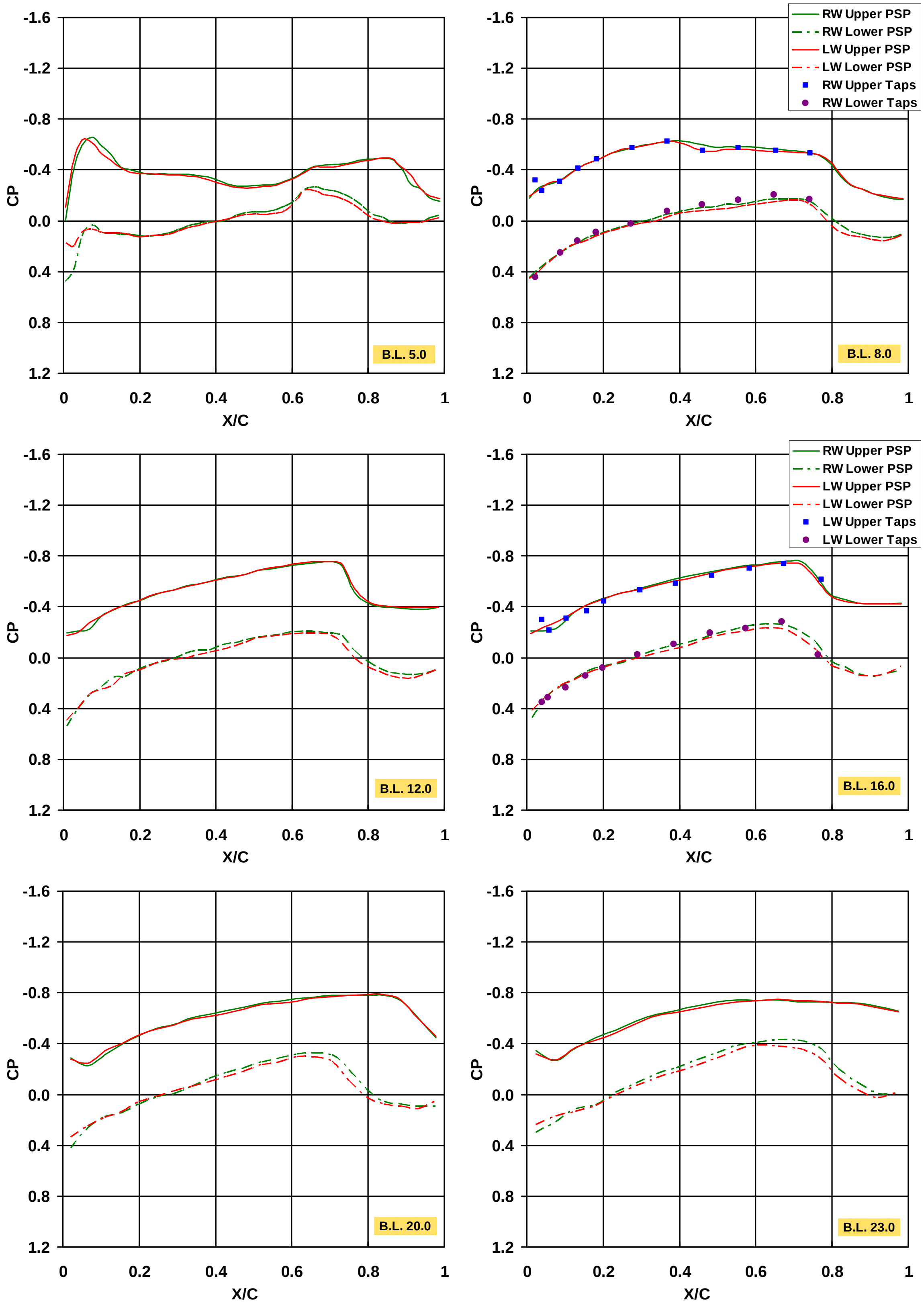


a. Alpha -3 deg.

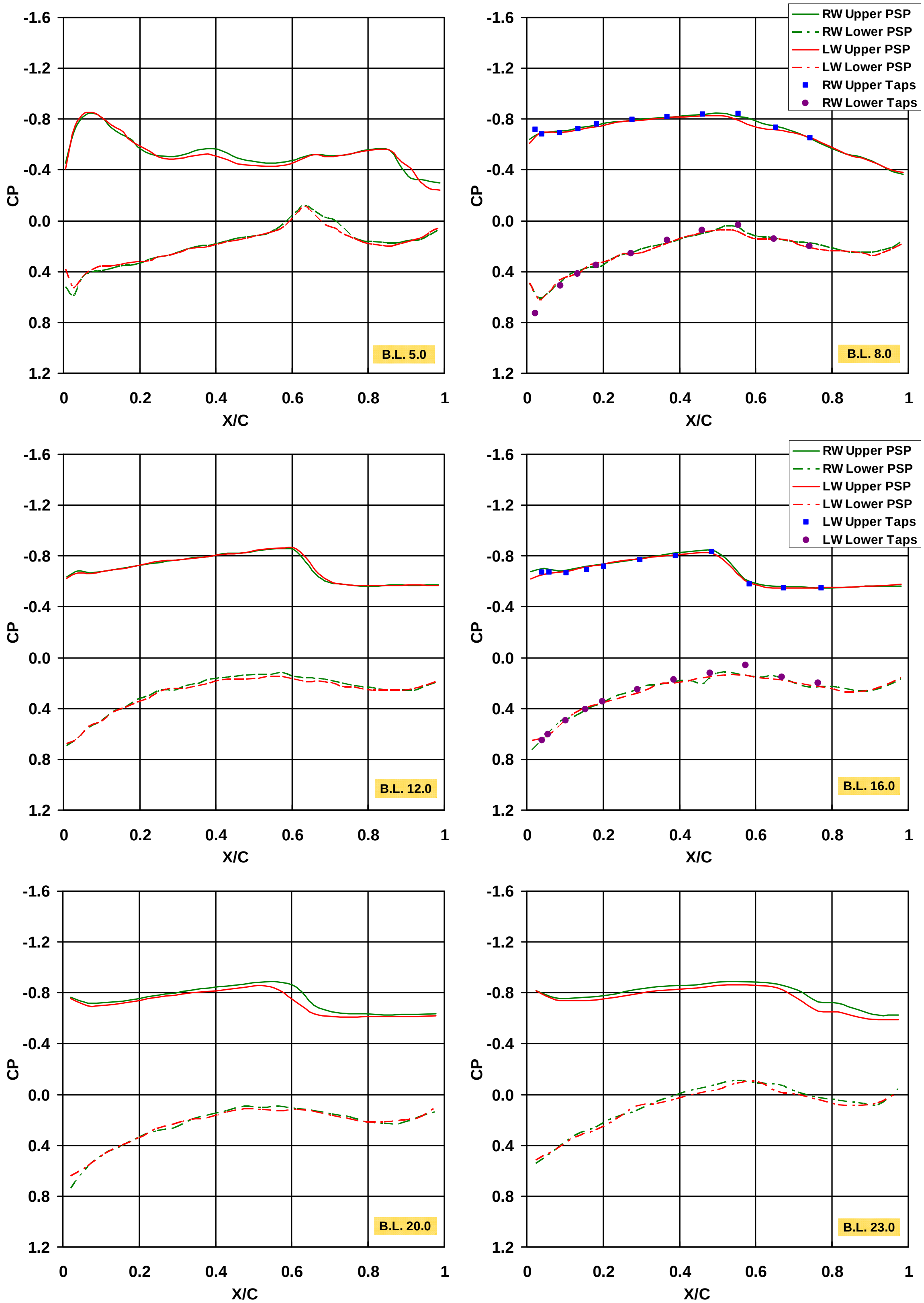
Figure 11. Mach Number 1.1 Wing Pressure Coefficient Comparison.



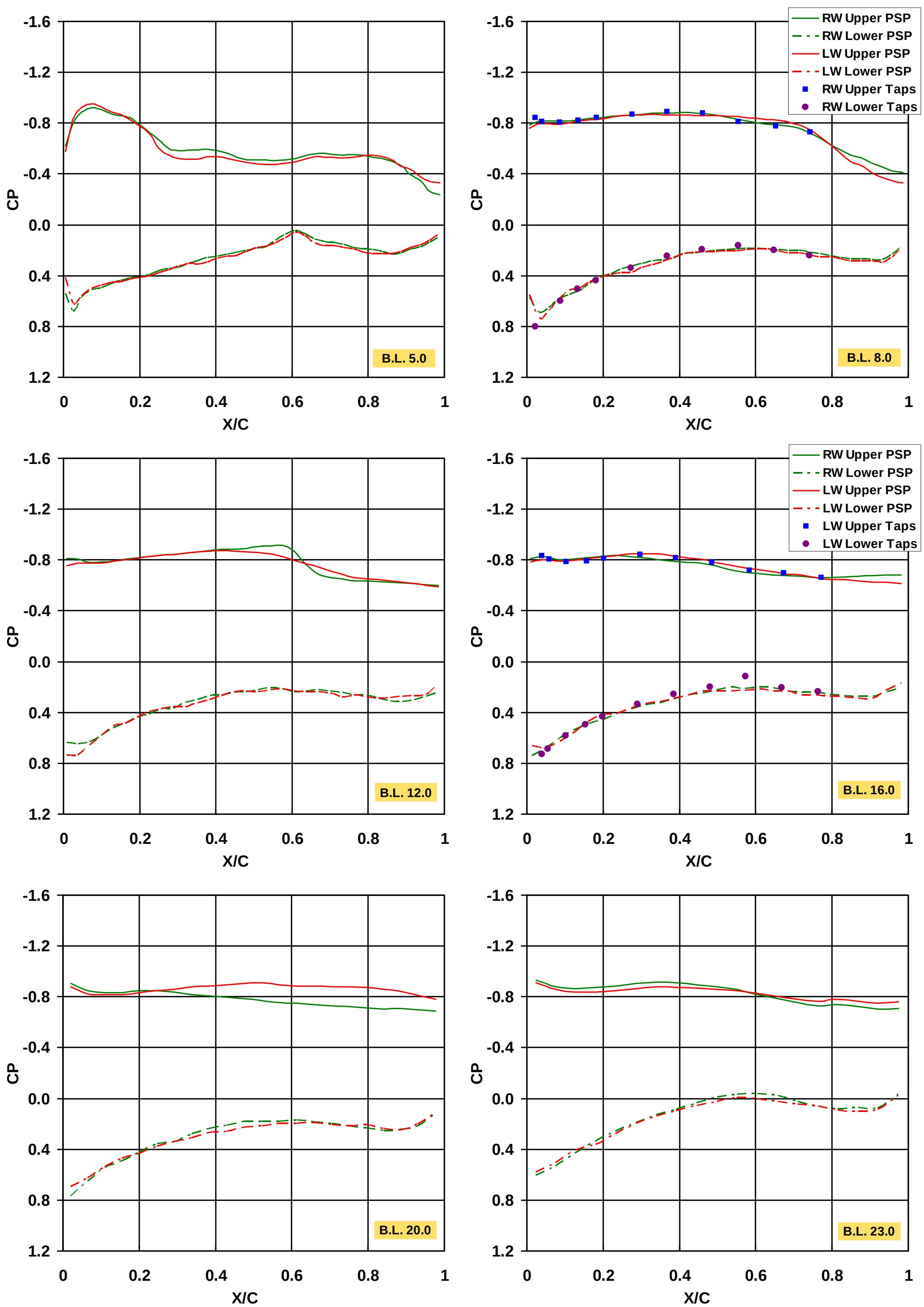
b. Alpha 0 deg.
Figure 11. Continued.



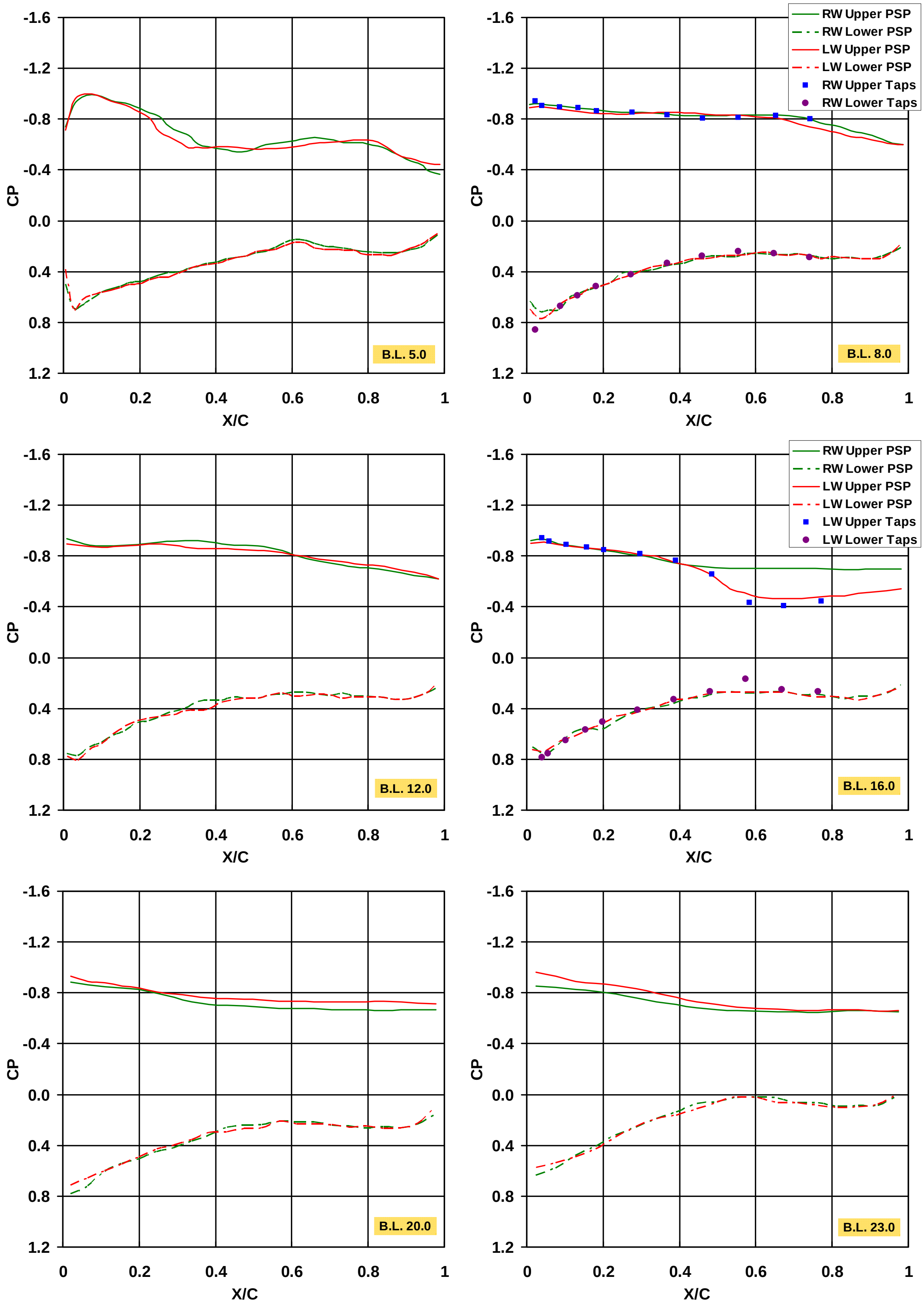
c. Alpha 5 deg.
Figure 11. Continued.



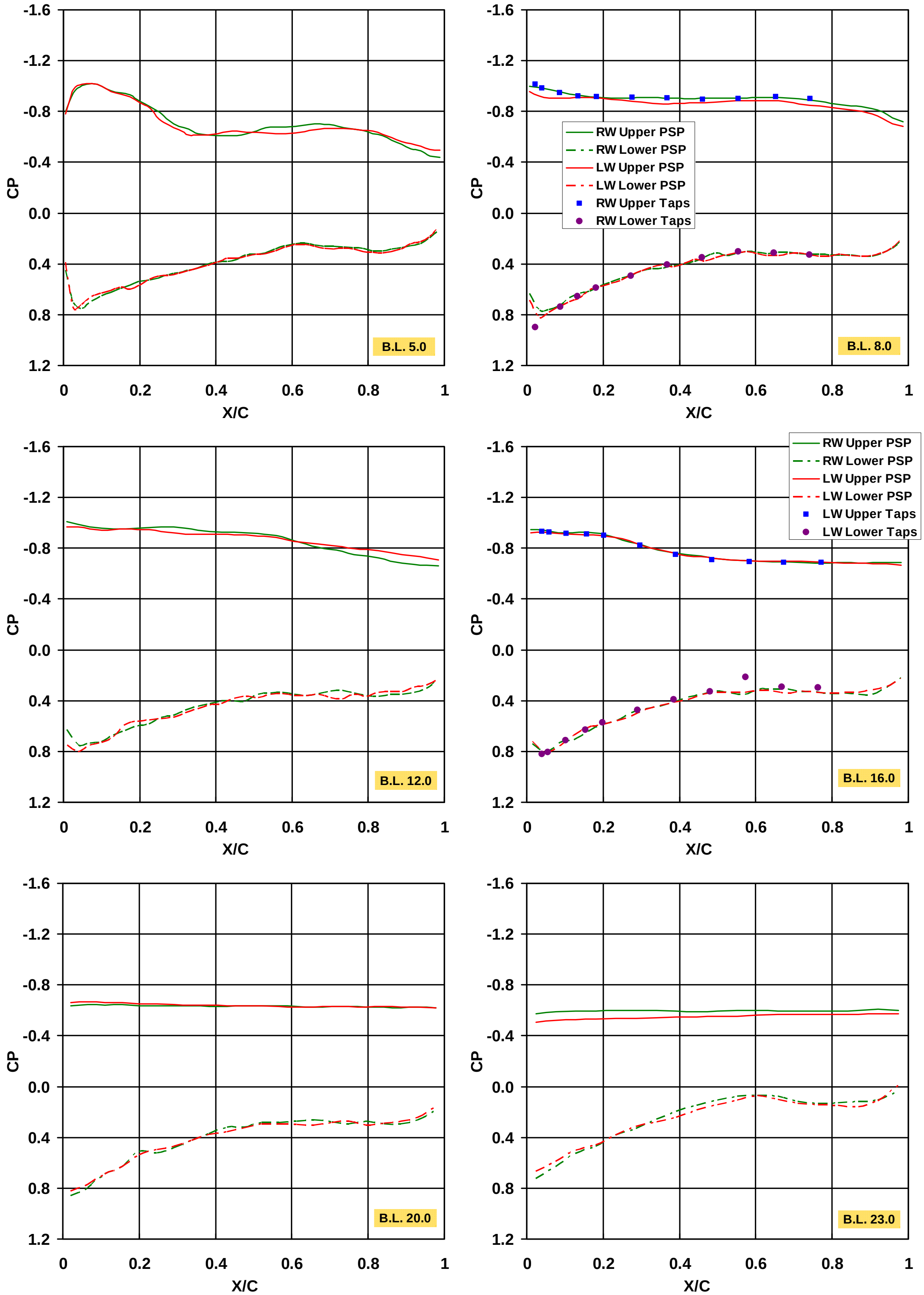
d. Alpha 10 deg.
Figure 11. Continued.



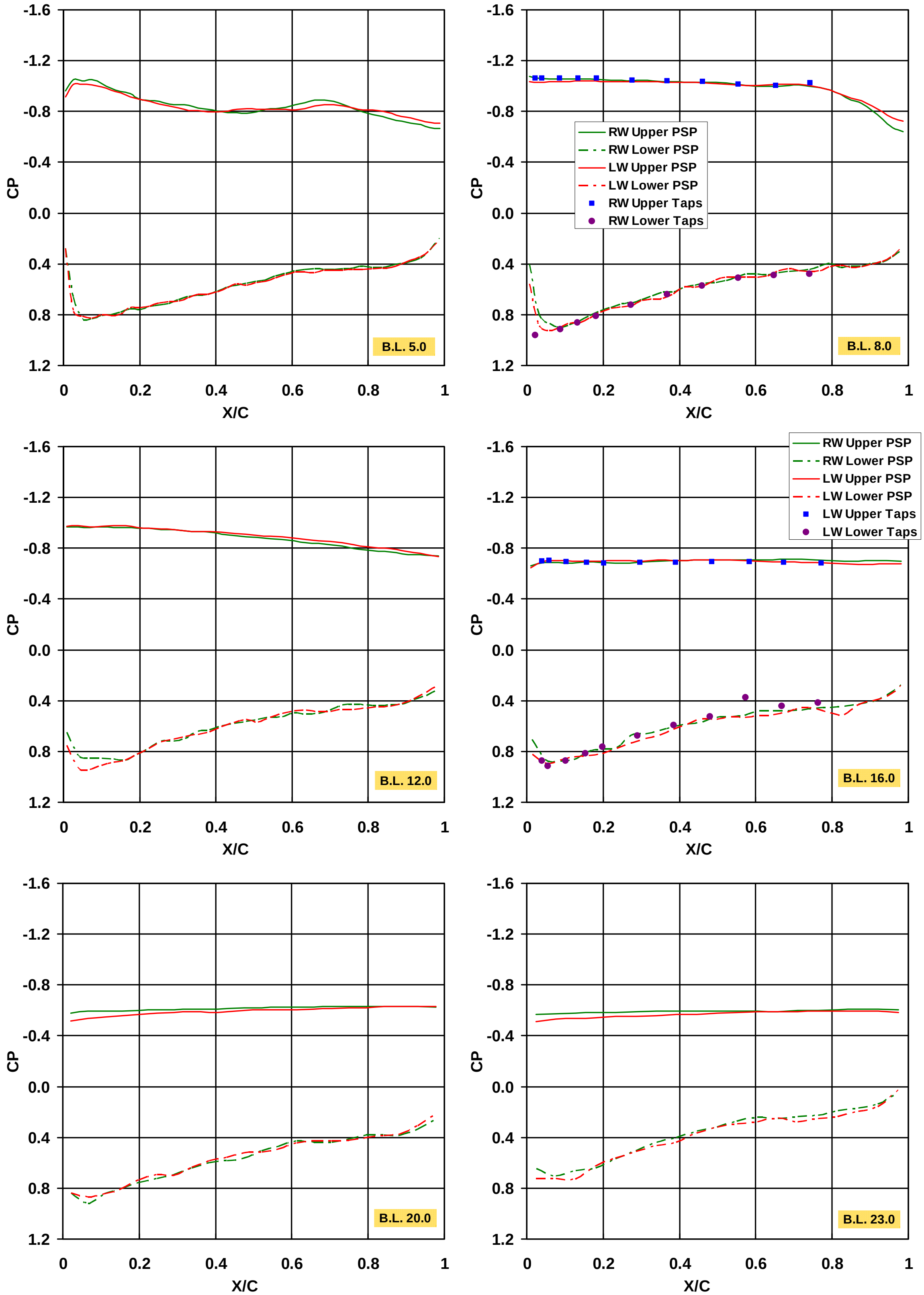
e. Alpha 12 deg.
Figure 11. Continued.



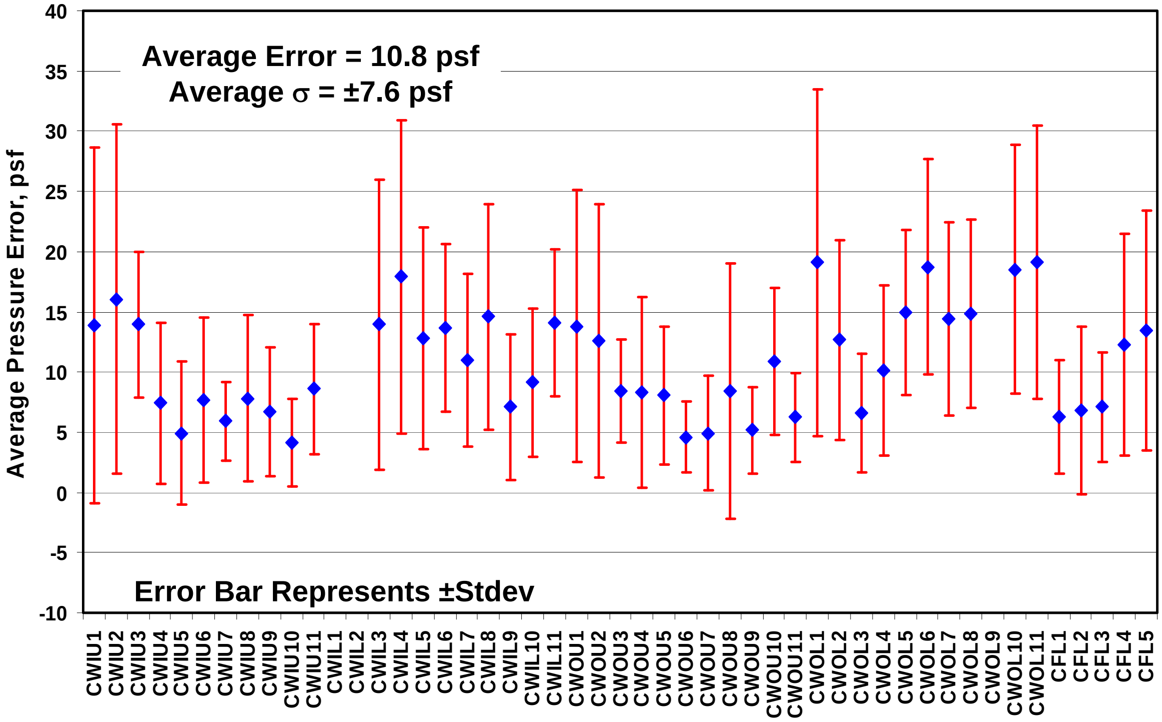
f. Alpha 14 deg.
Figure 11. Continued.



g. Alpha 16 deg.
Figure 11. Continued.

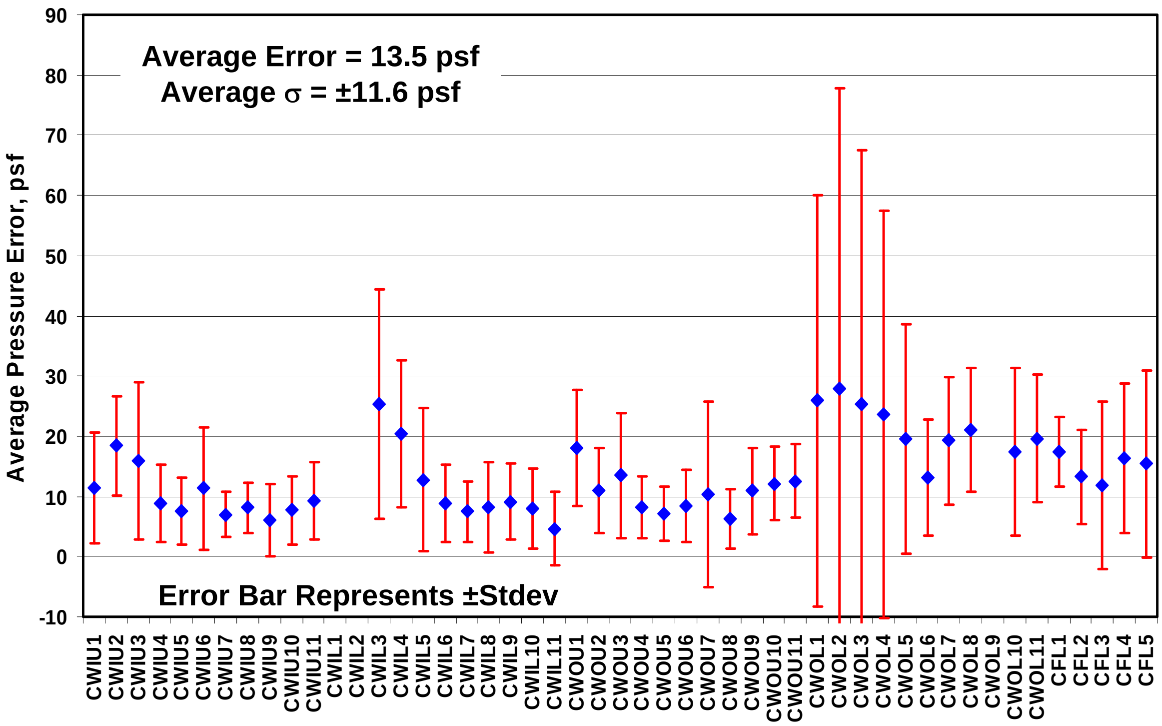


h. Alpha 24 deg.
Figure 11. Concluded.



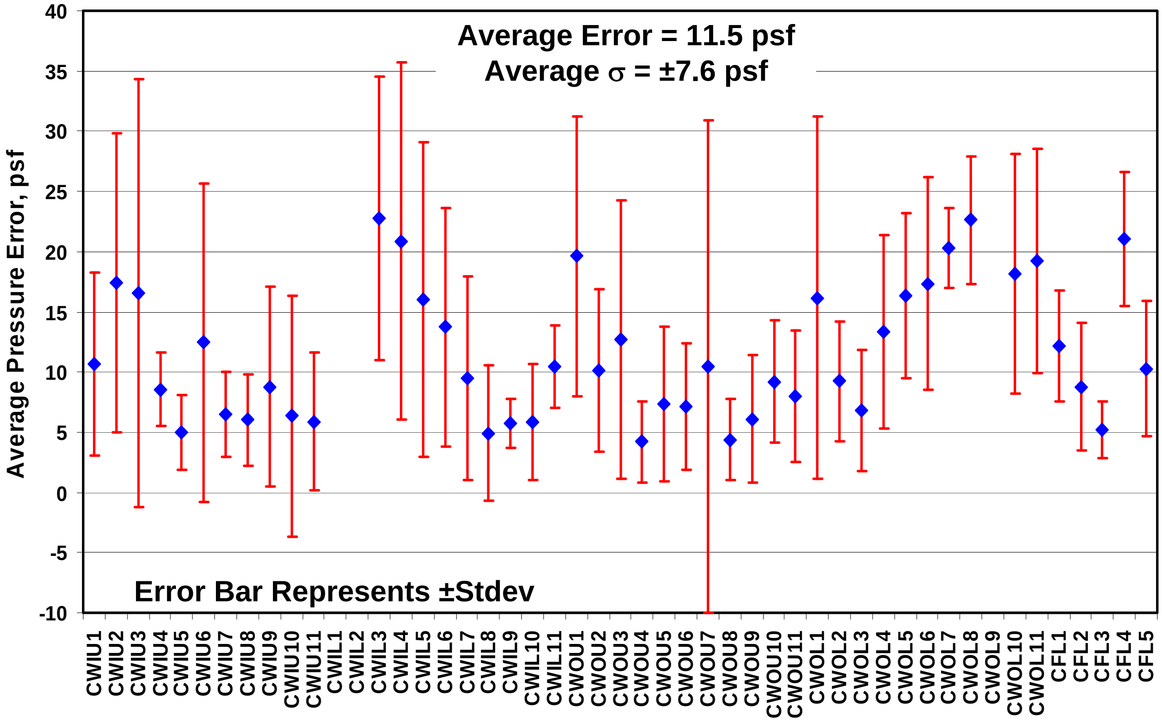
a. Mach 0.4

Figure12. Pressure Error Between PSP and Conventional Pressure Orifices.

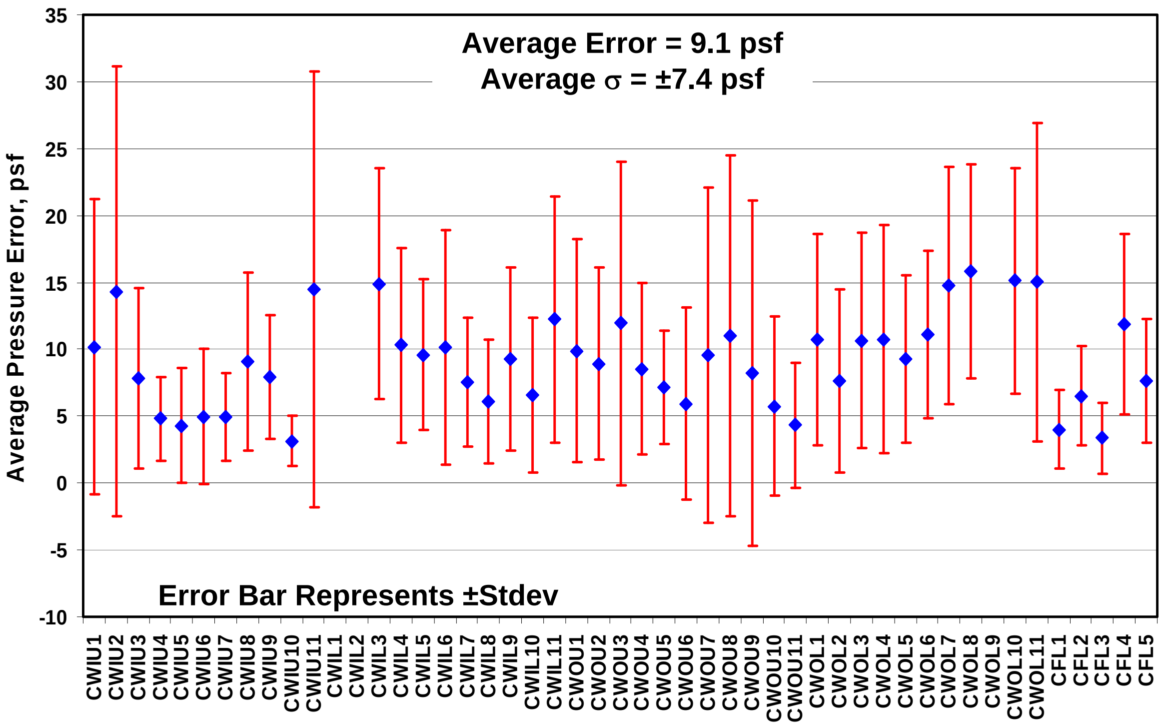


b. Mach 0.8

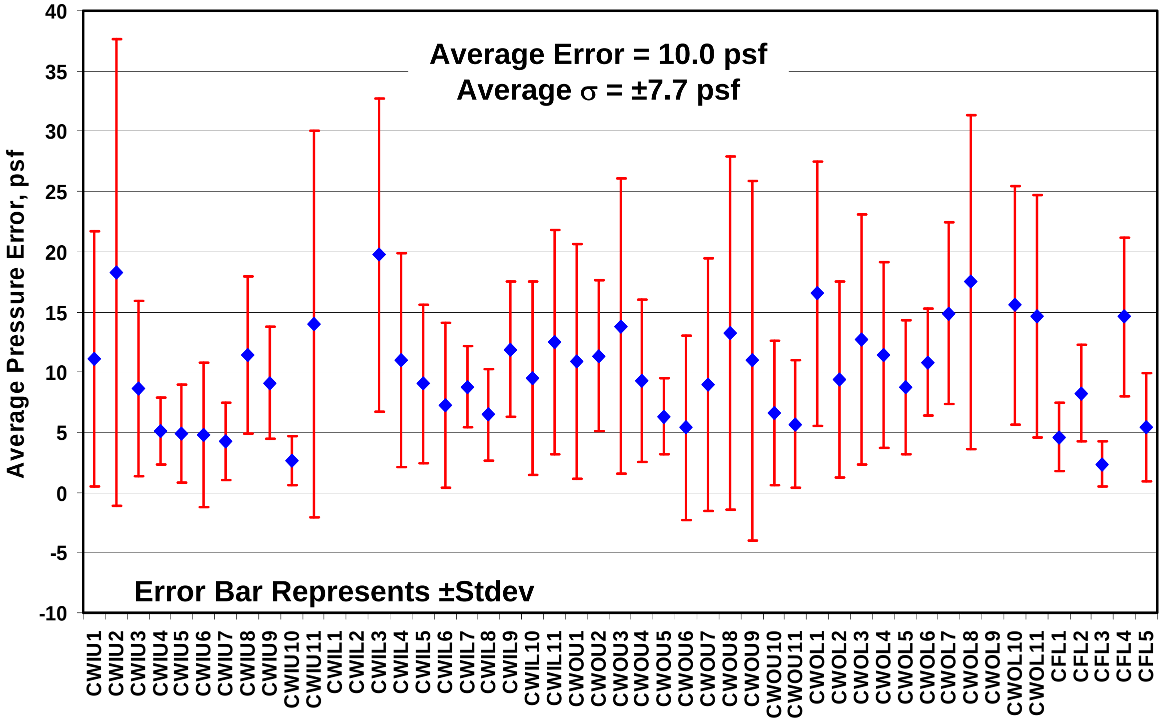
Figure 12. Continued.



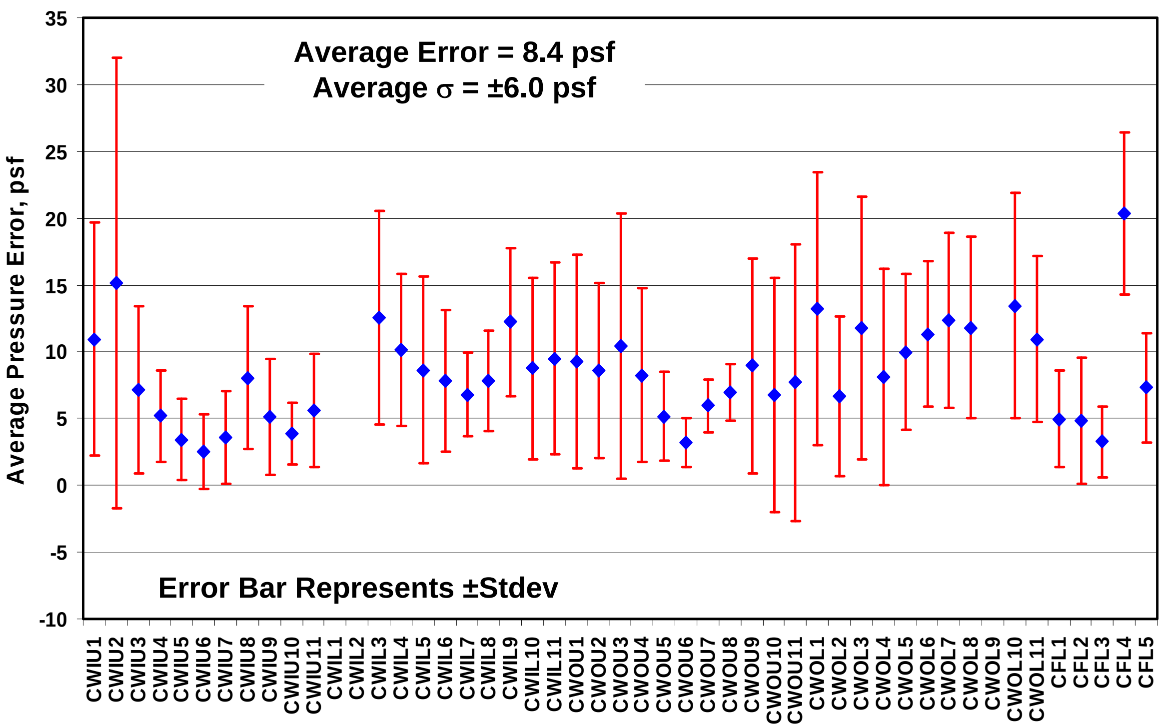
c. Mach 0.8 Repeat
Figure 12. Continued.



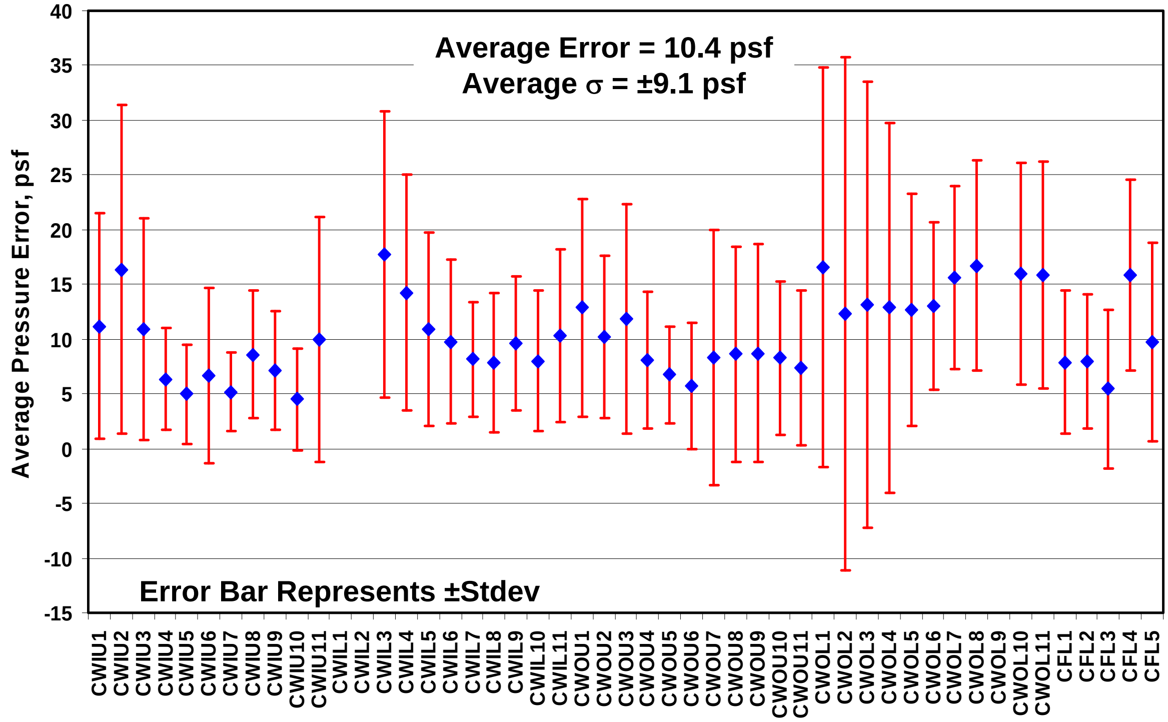
d. Mach 0.95
Figure 12. Continued.



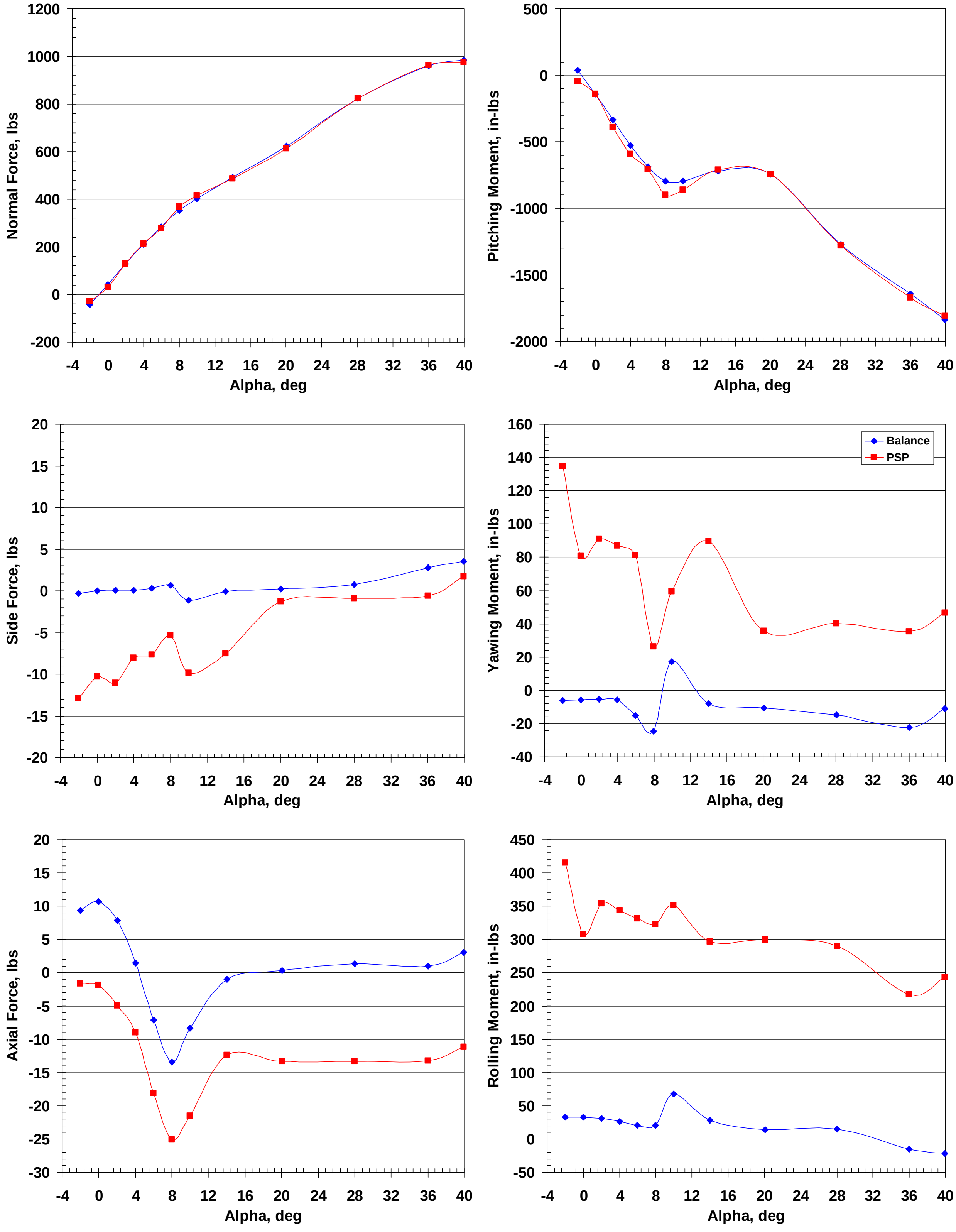
e. Mach 0.95 Repeat
Figure 12. Continued.



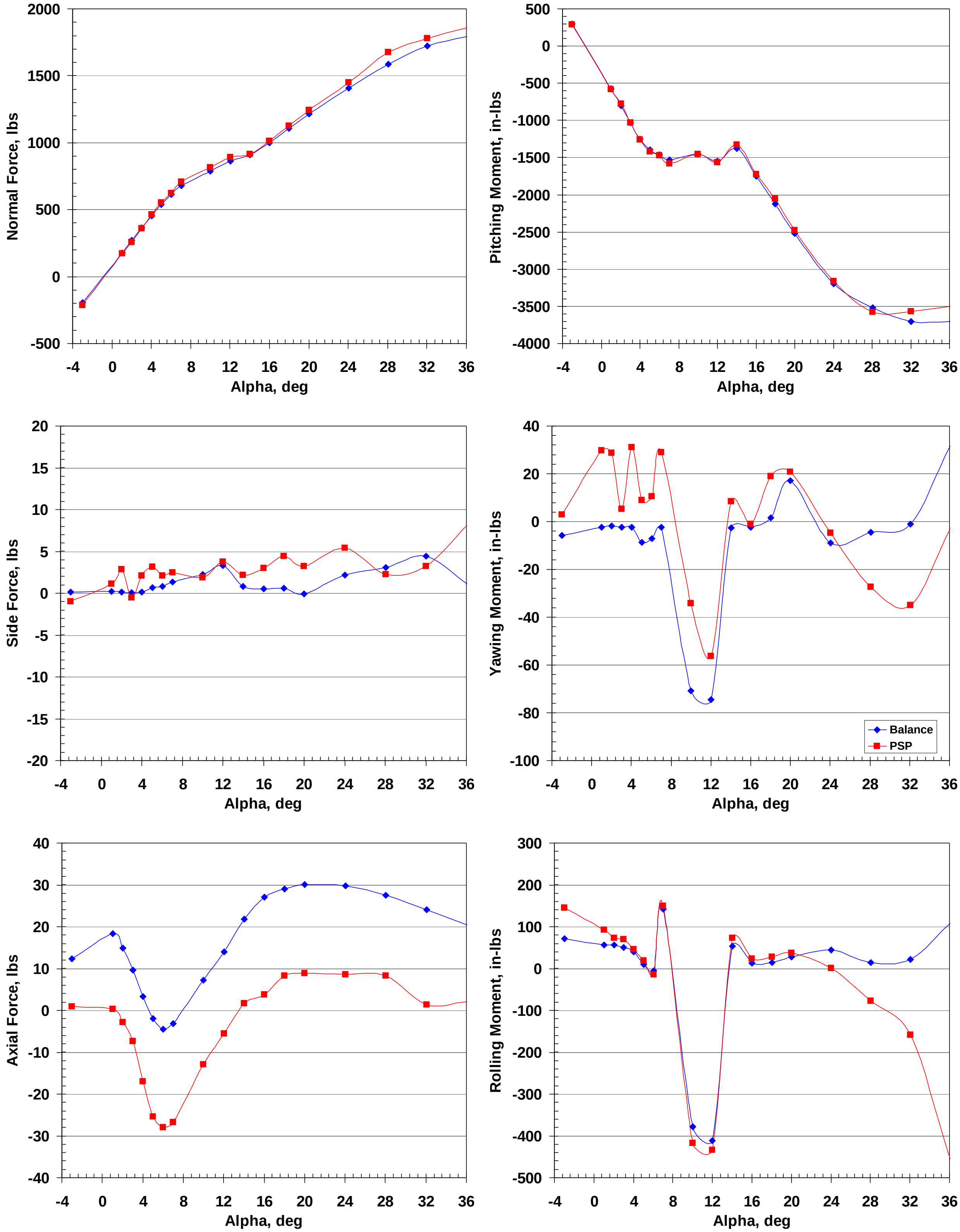
f. Mach 1.1
Figure 12. Continued.



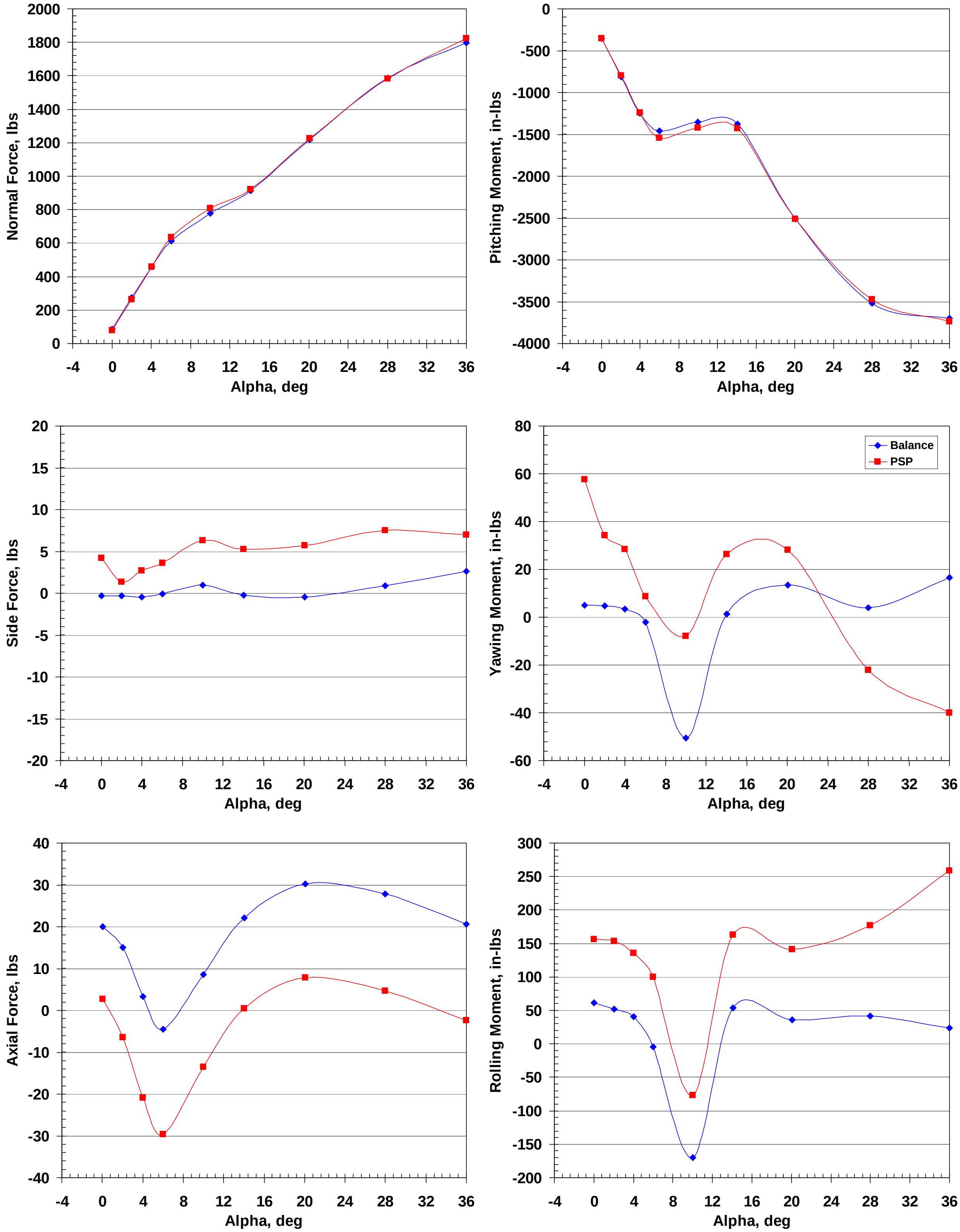
e. All Mach Numbers
Figure 12. Concluded.



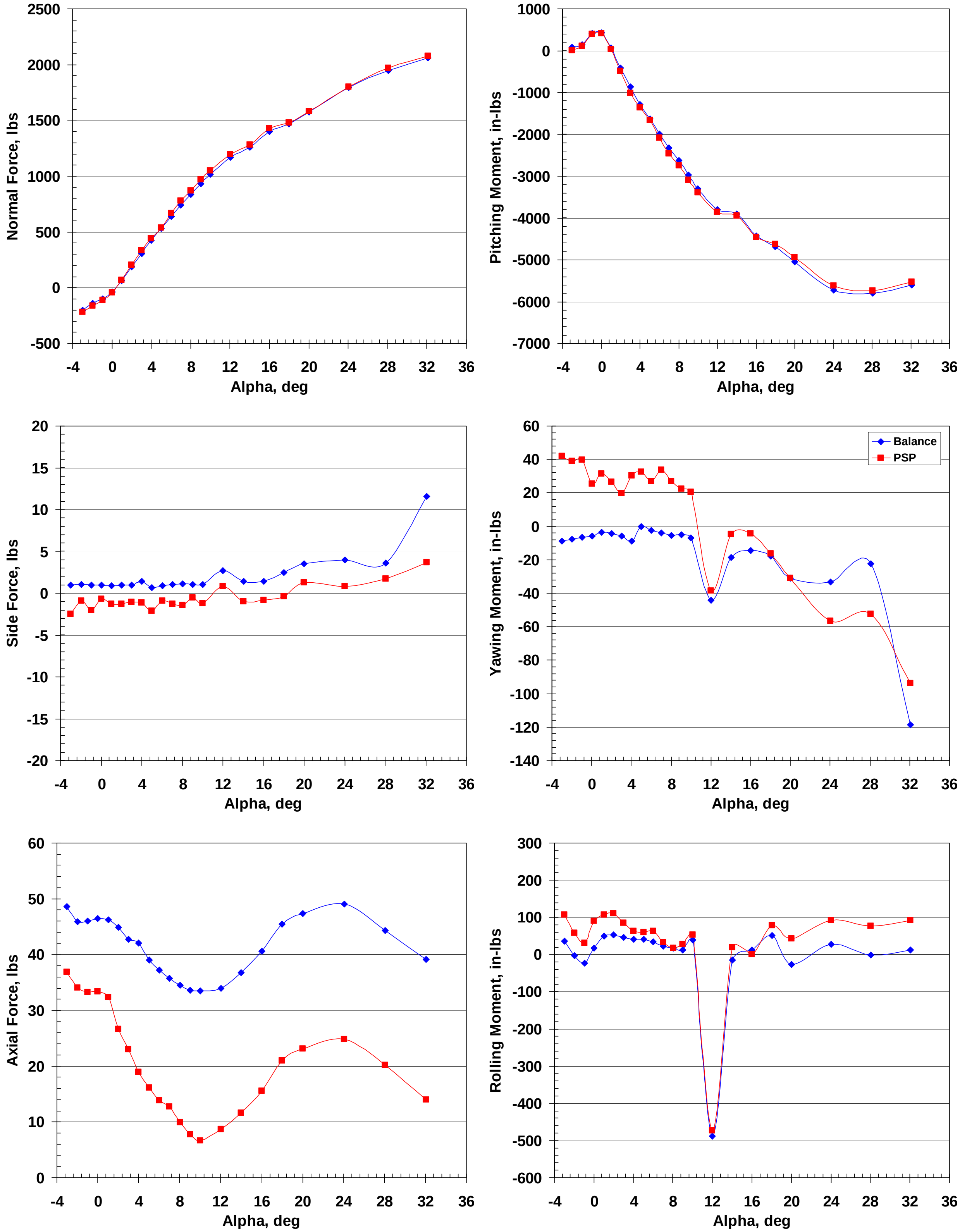
a. Mach Number 0.4.
Figure 13. Total Integrated Loads.



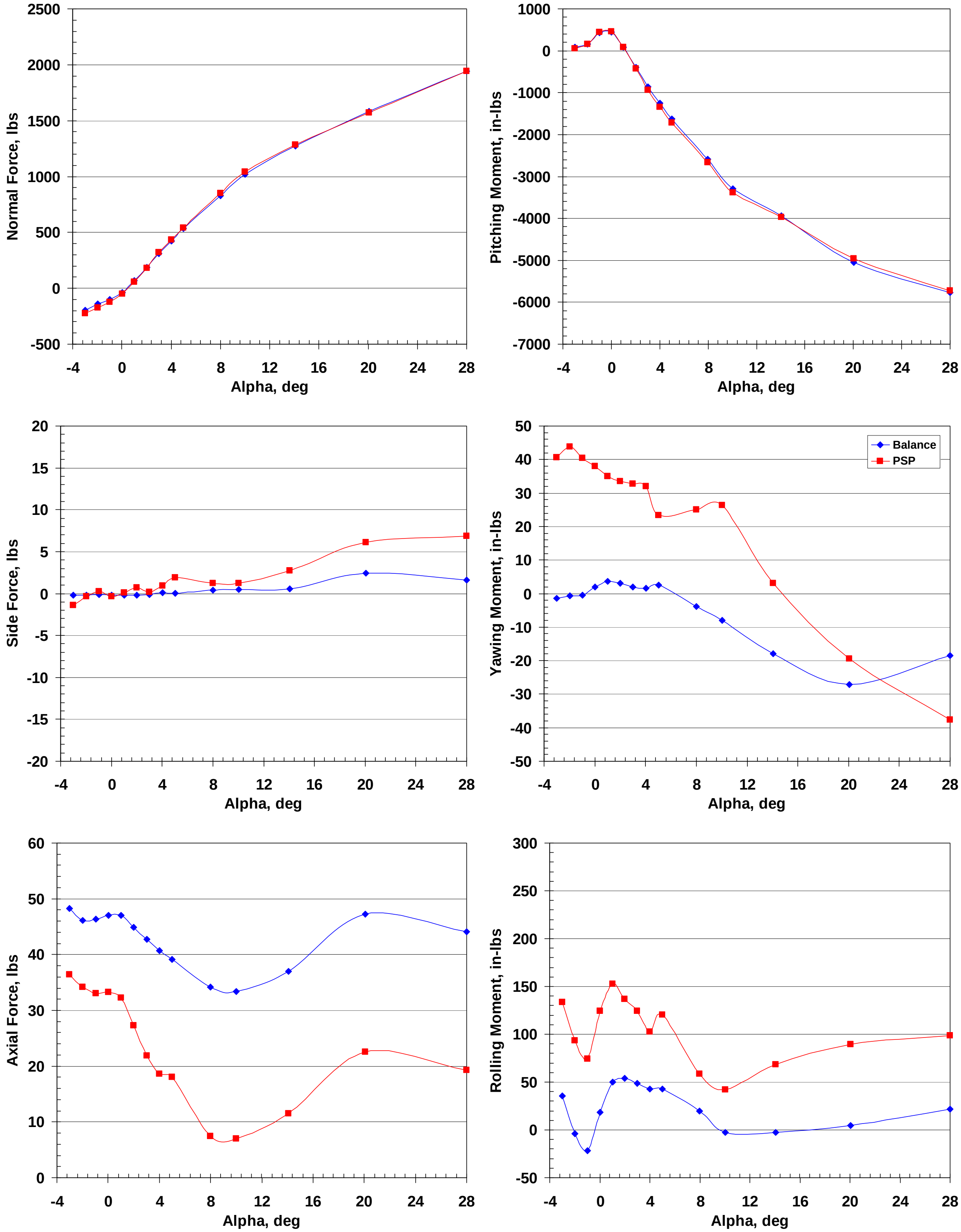
b. Mach Number 0.8.
Figure 13. Continued.



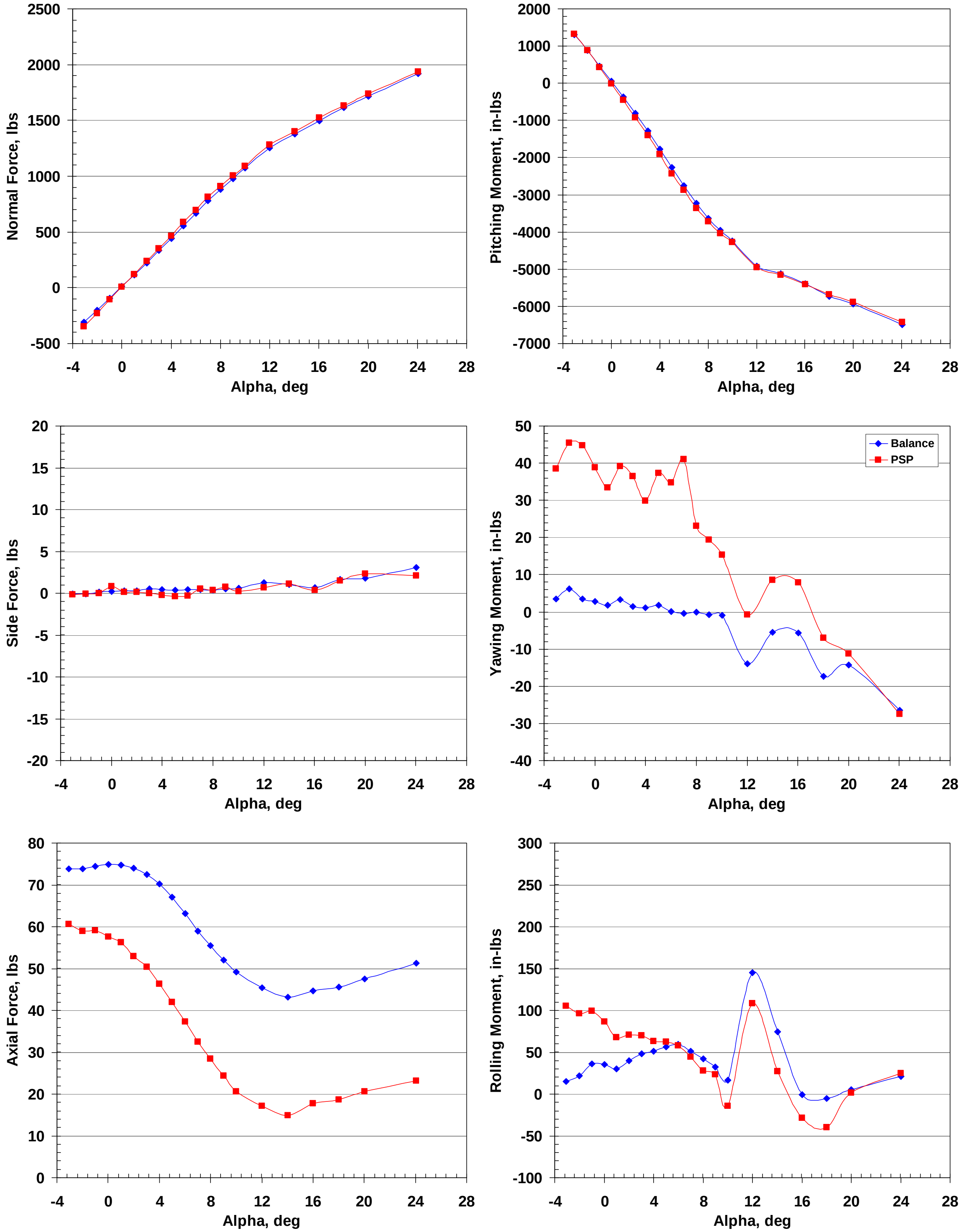
c. Mach Number 0.8 Repeat.
Figure 13. Continued.



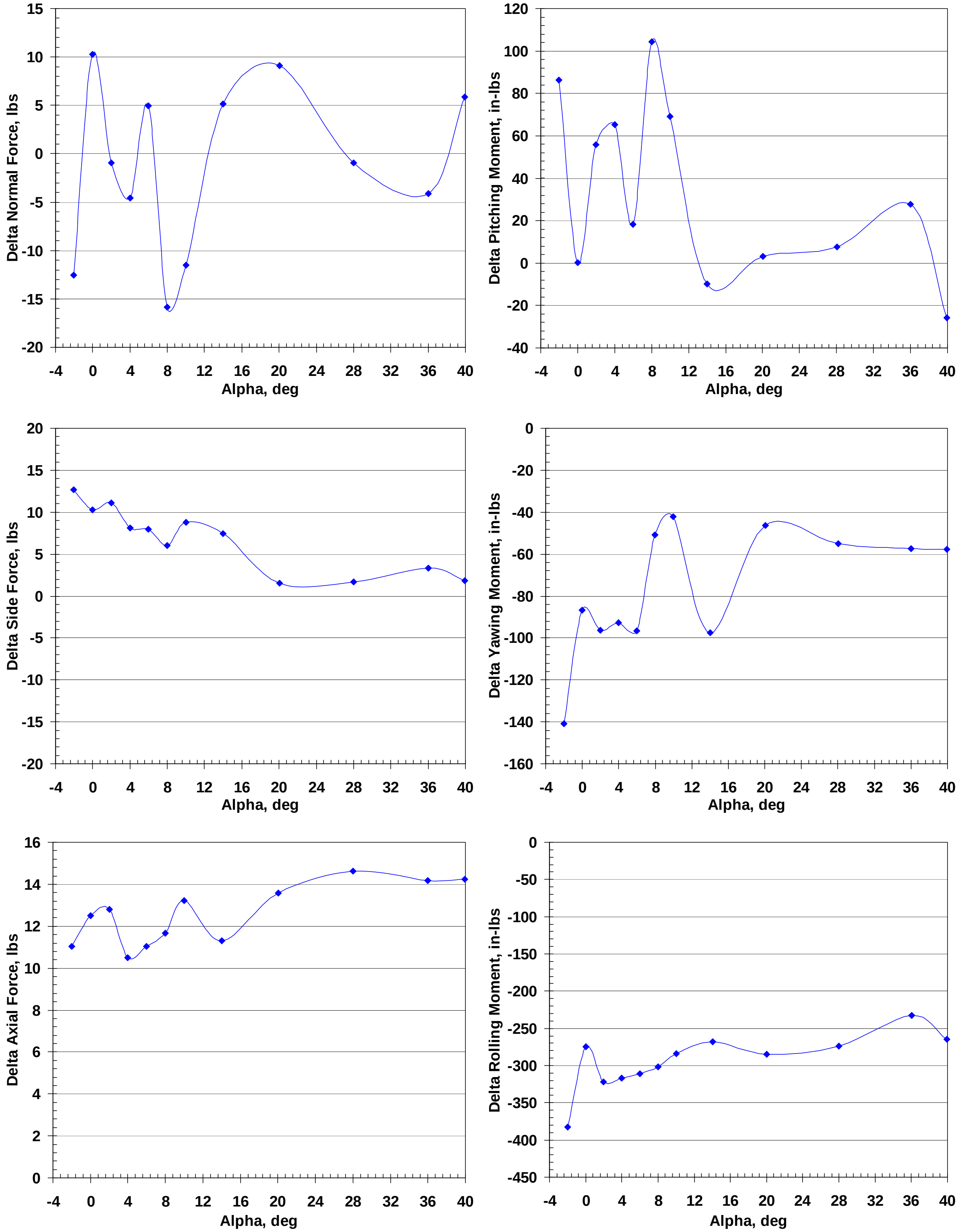
d. Mach Number 0.95.
Figure 13. Continued.



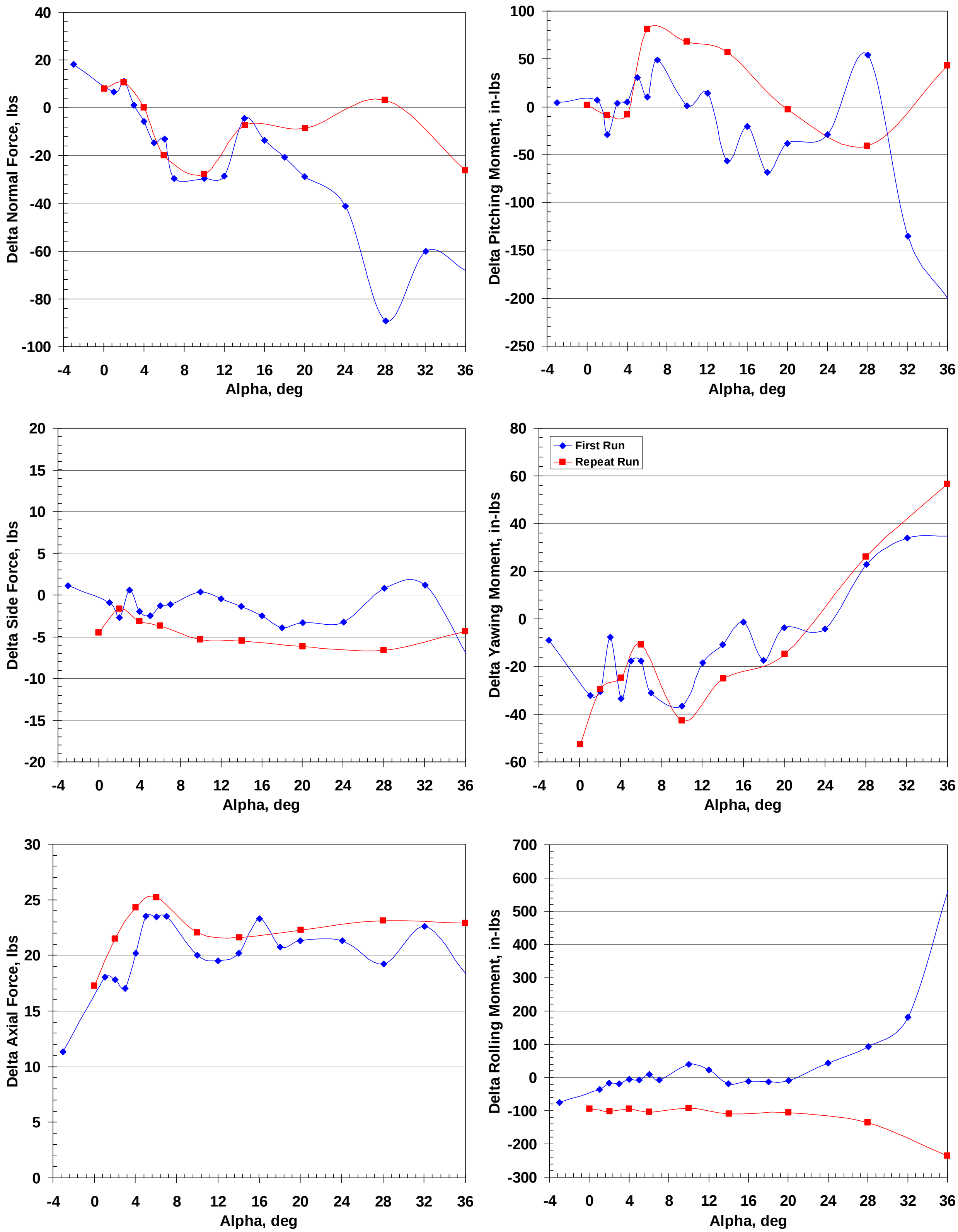
e. Mach Number 0.95 Repeat.
Figure 13. Continued.



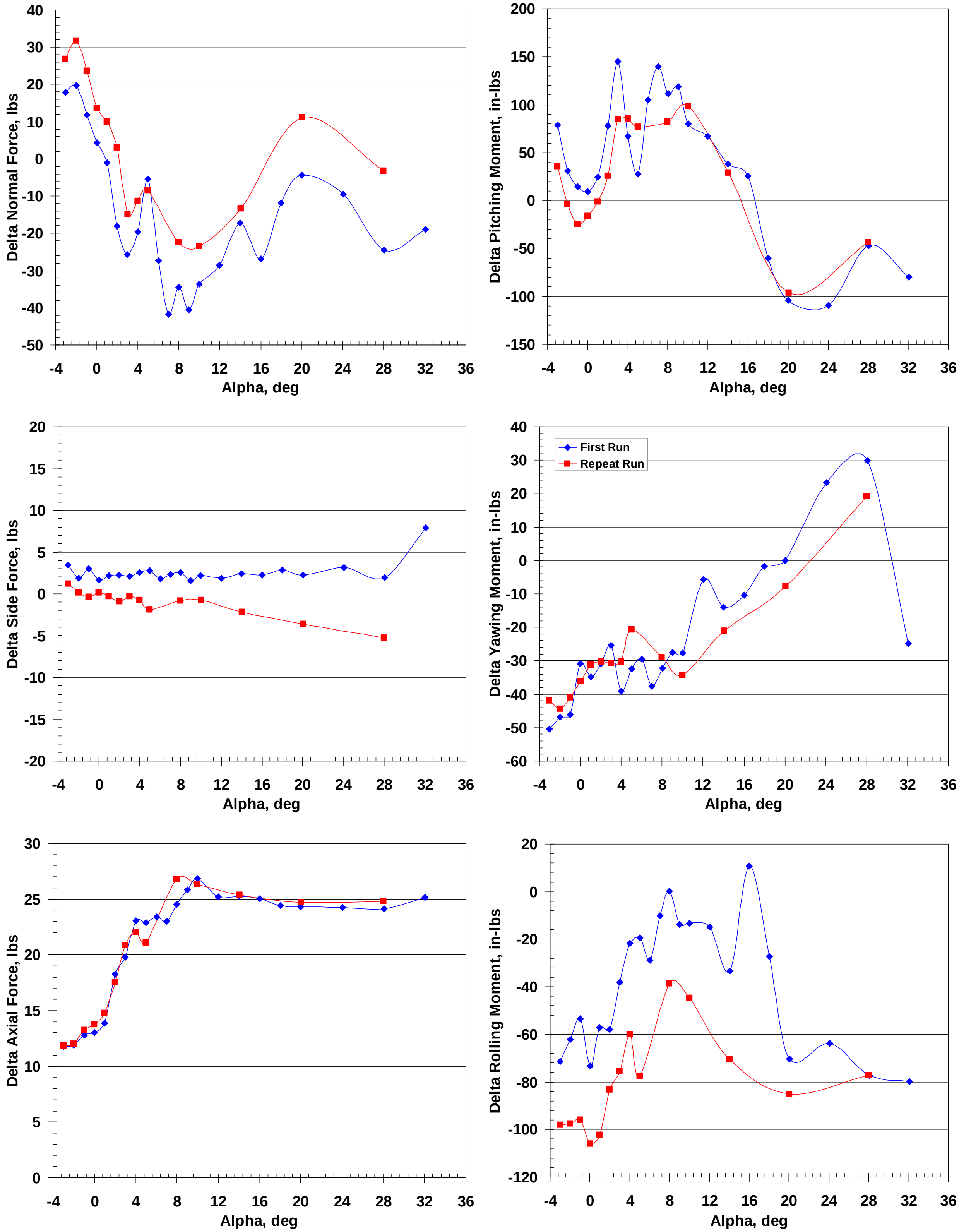
f. Mach Number 1.1.
Figure 13. Concluded.



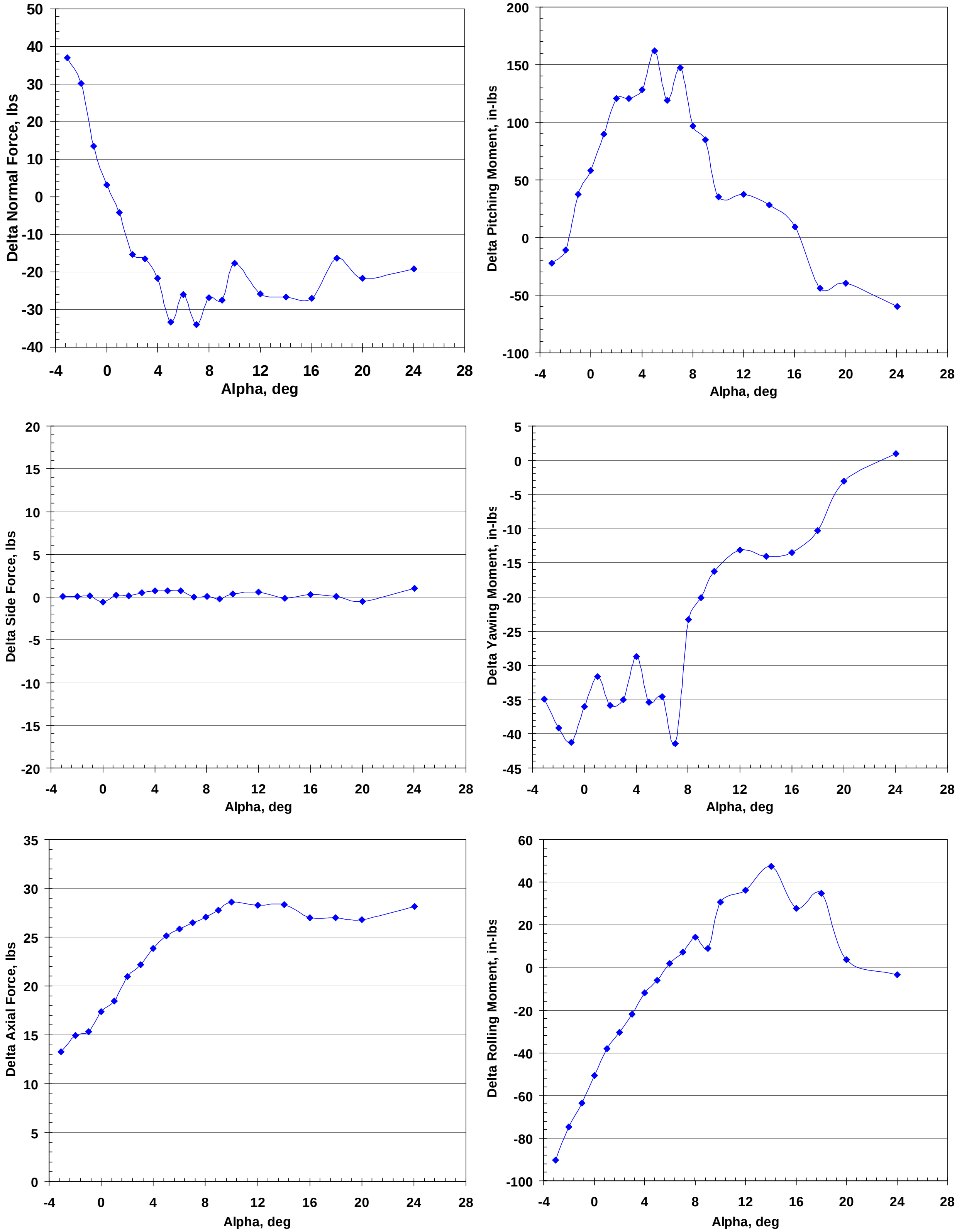
a. Mach Number 0.4.
Figure 14. Delta Loads Between Balance and PSP Integration.



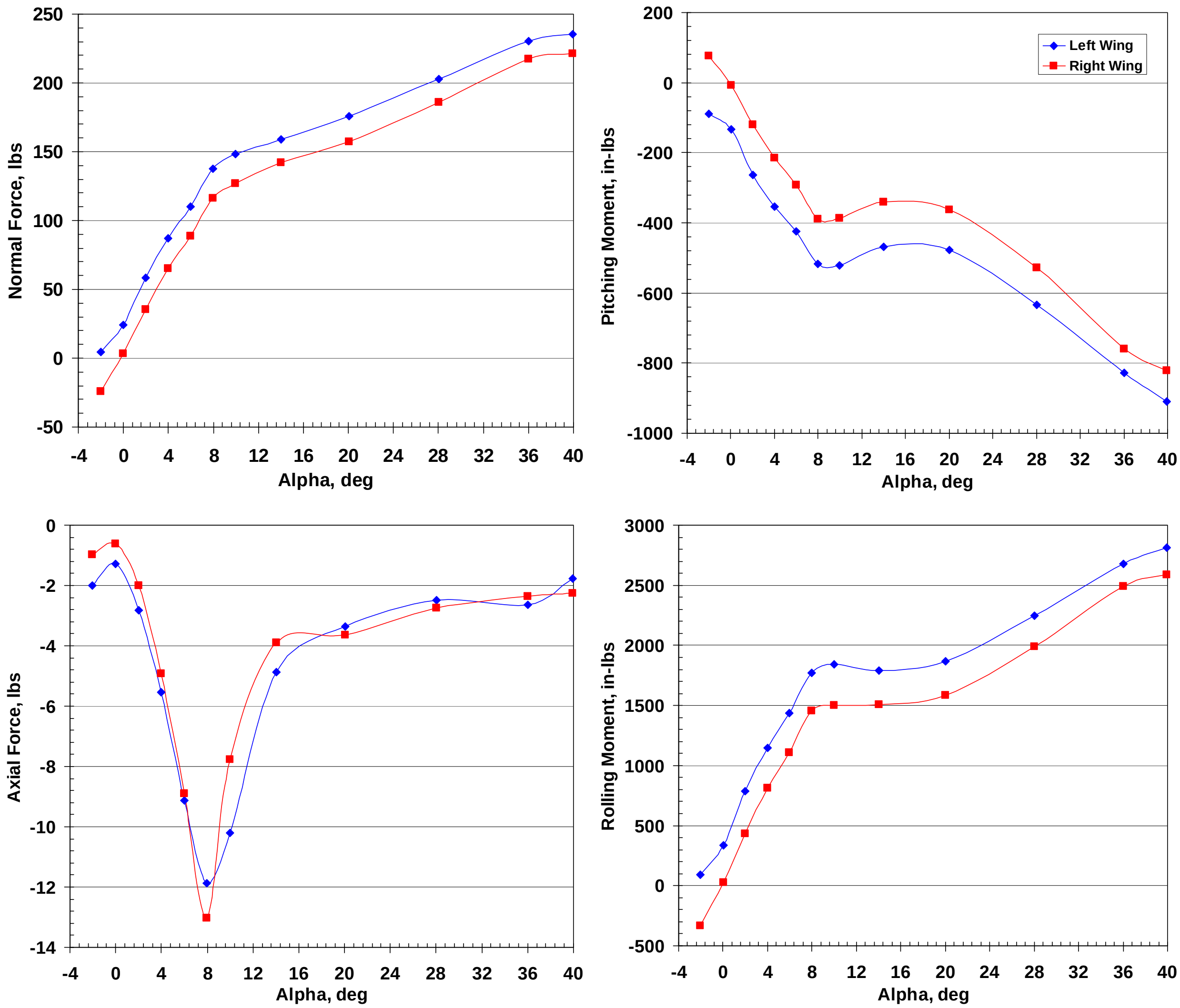
b Mach Number 0.8.
Figure 14. Continued.



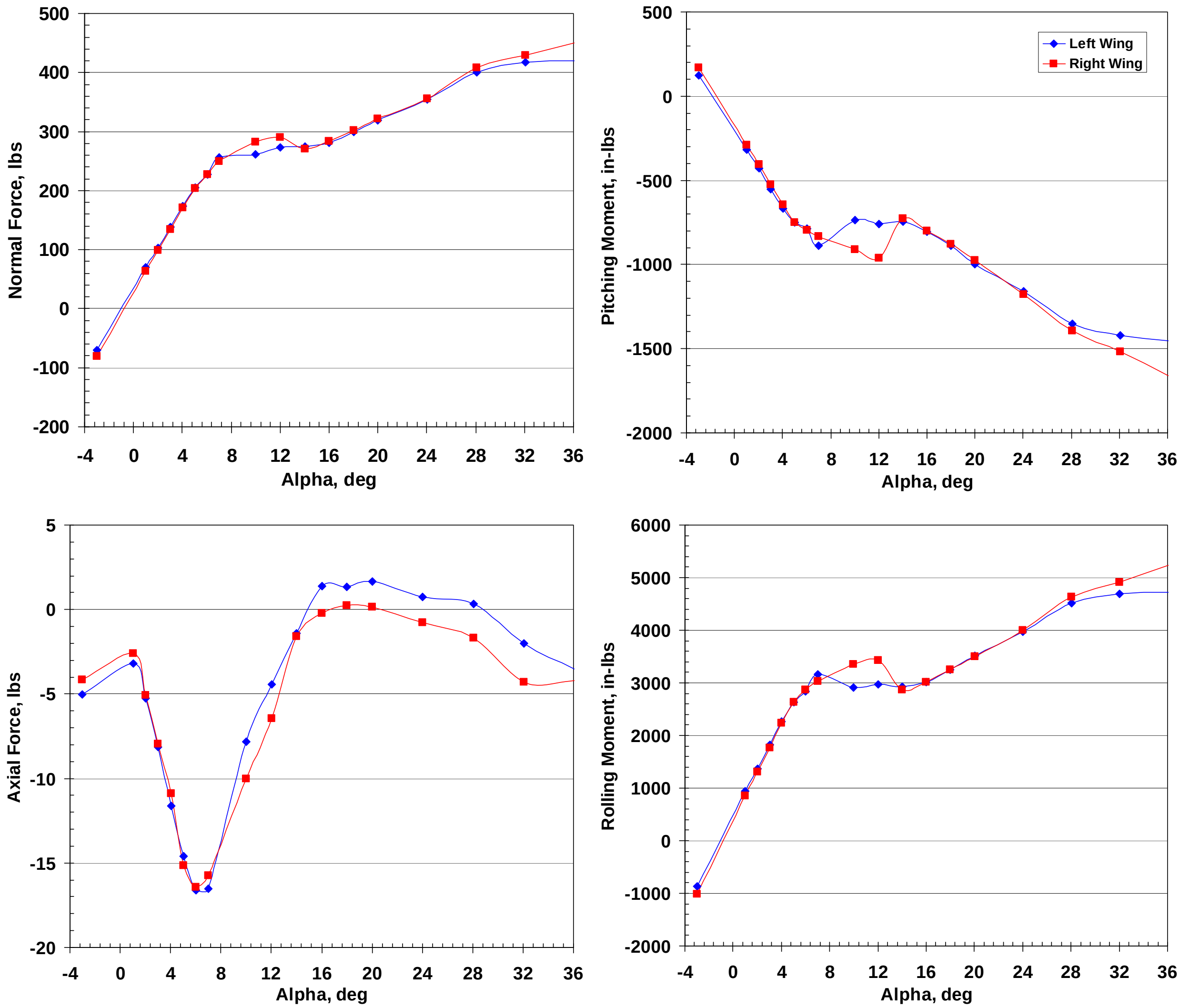
c. Mach Number 0.95.
Figure 14. Continued.



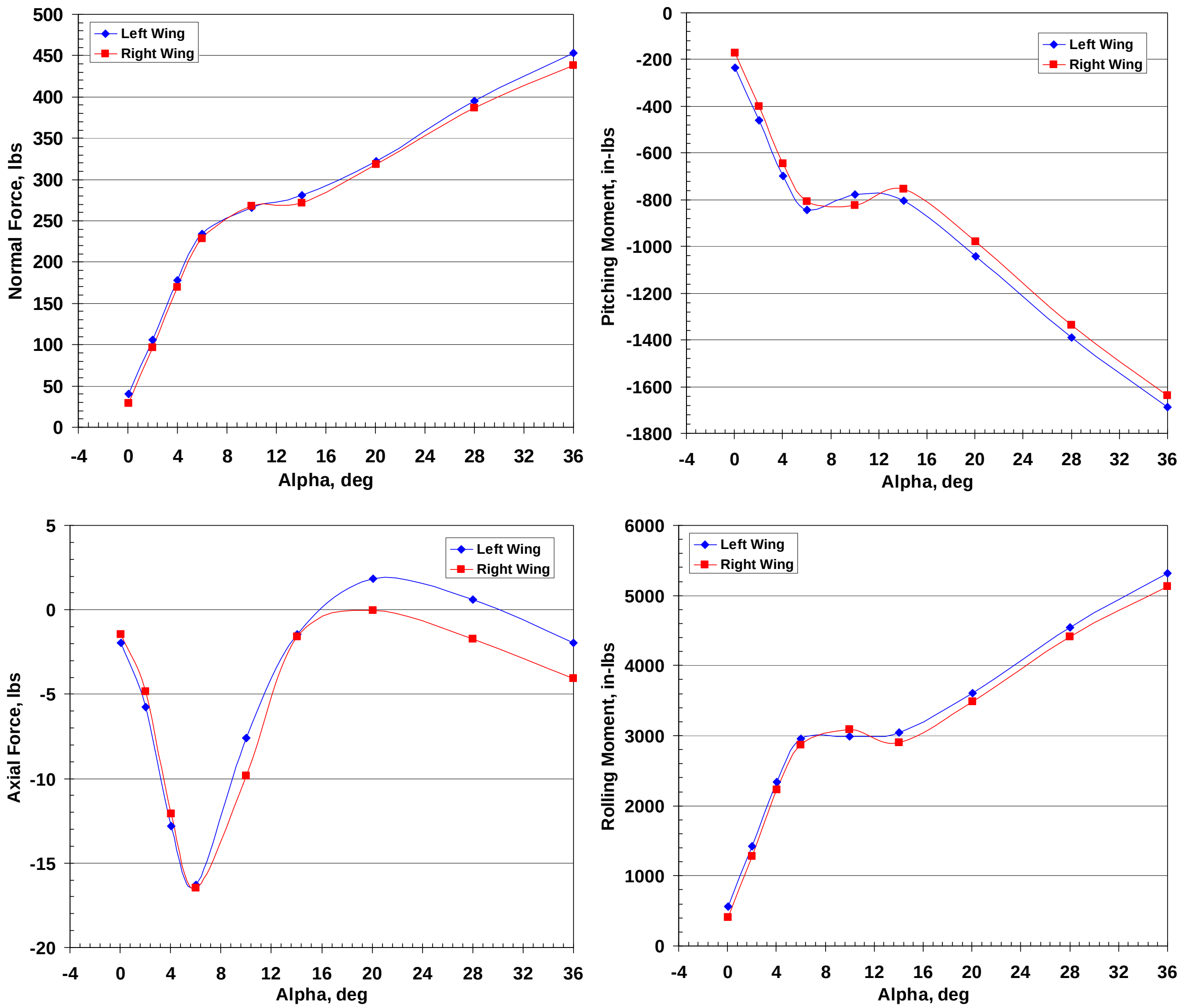
d. Mach Number 1.1.
Figure 14. Concluded.



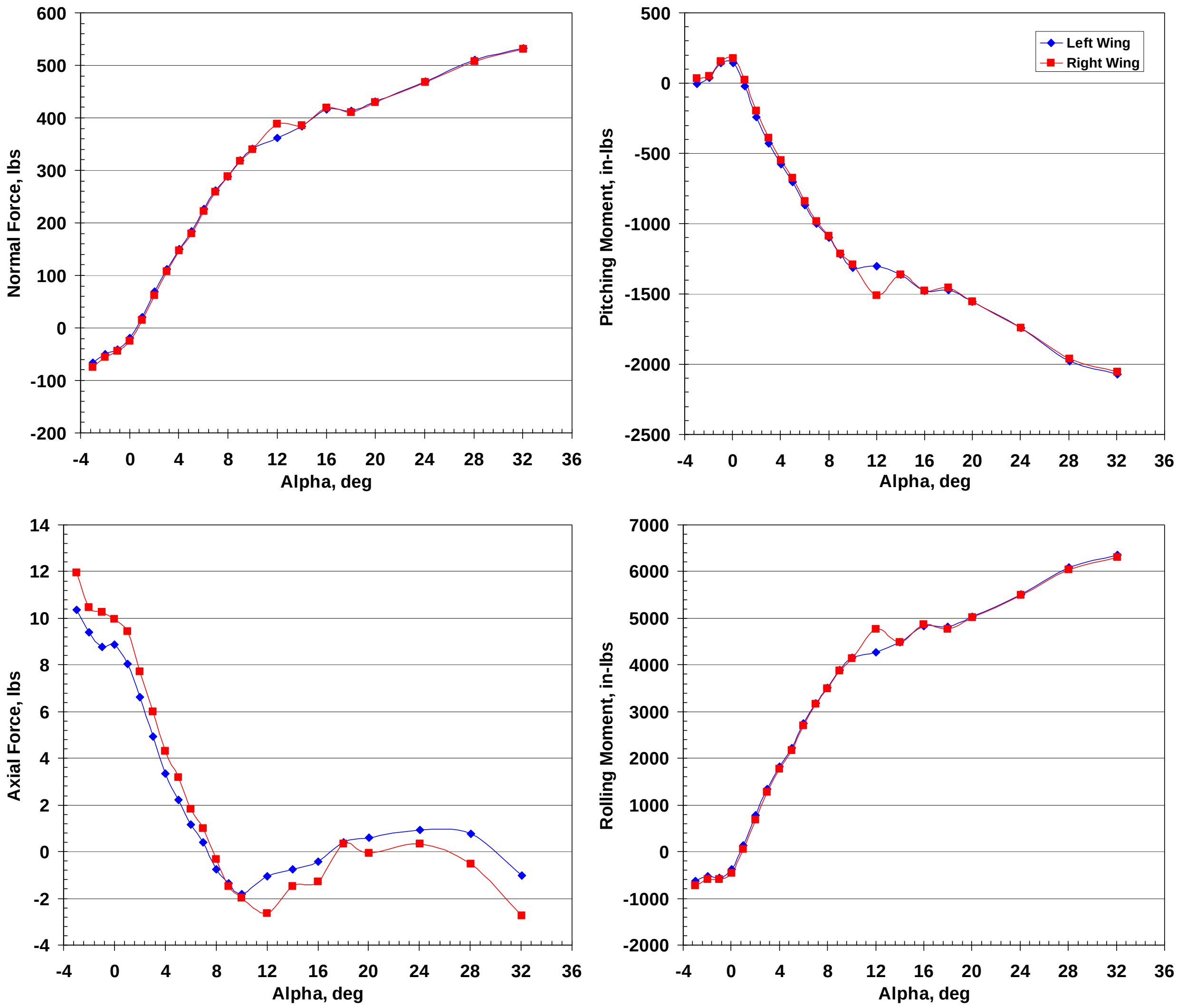
a. Mach Number 0.4.
Figure 15. Integrated Loads for the Left and Right Wings.



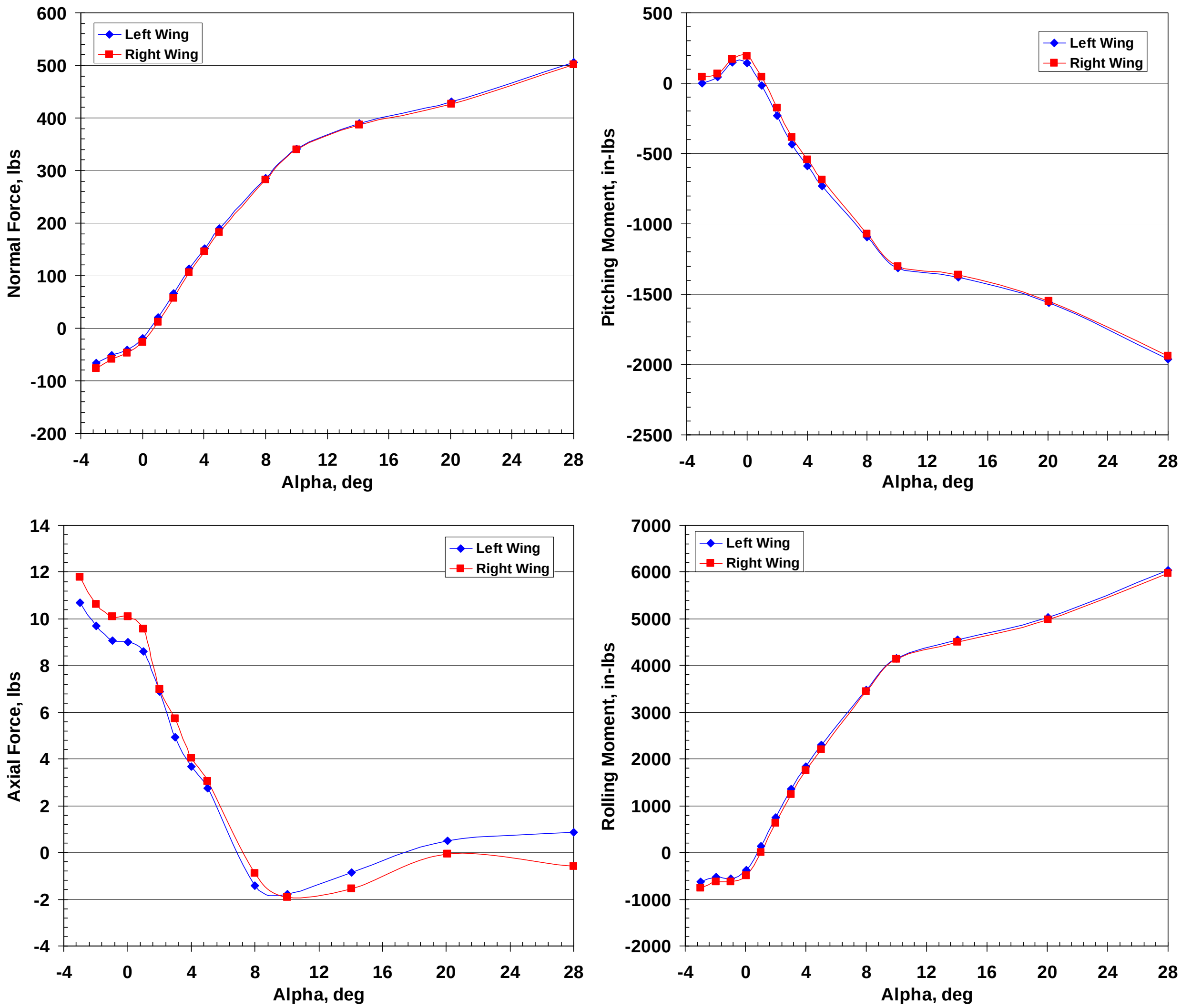
b. Mach Number 0.8.
Figure 15. Continued.



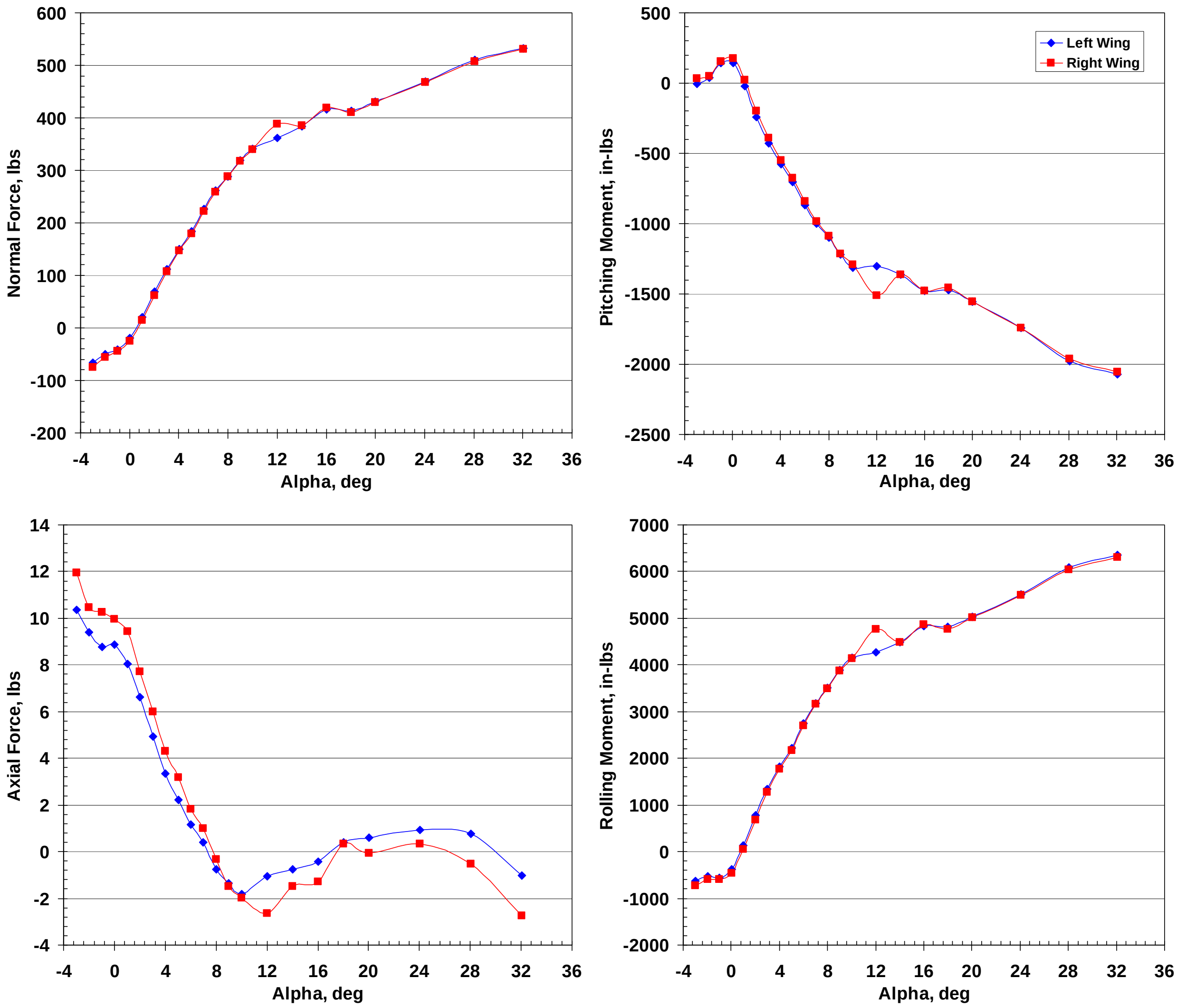
c. Mach Number 0.8 Repeat.
Figure 15. Continued.



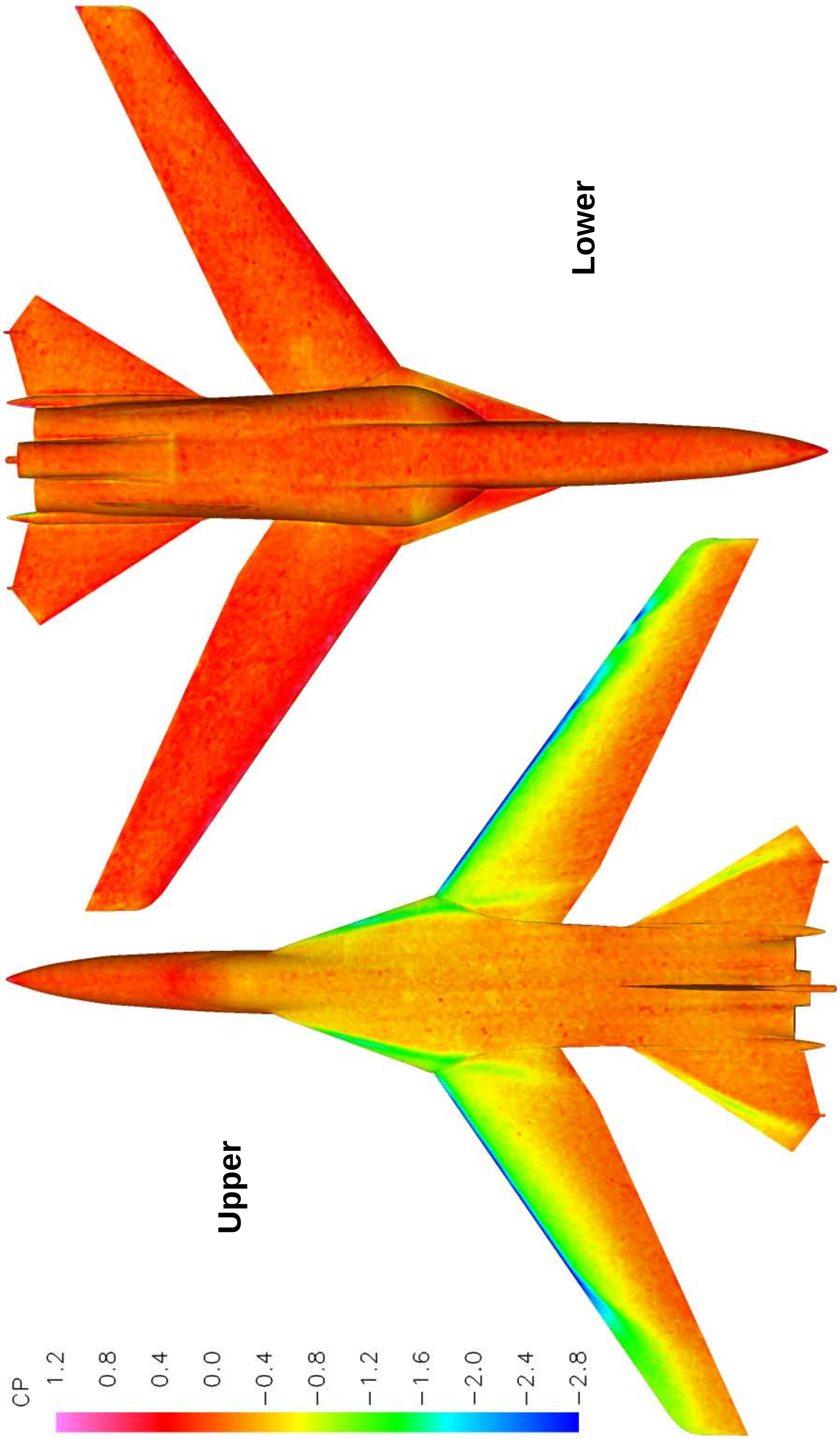
d. Mach Number 0.95.
Figure 15. Continued.



e. Mach Number 0.95 Repeat.
Figure 15. Continued.

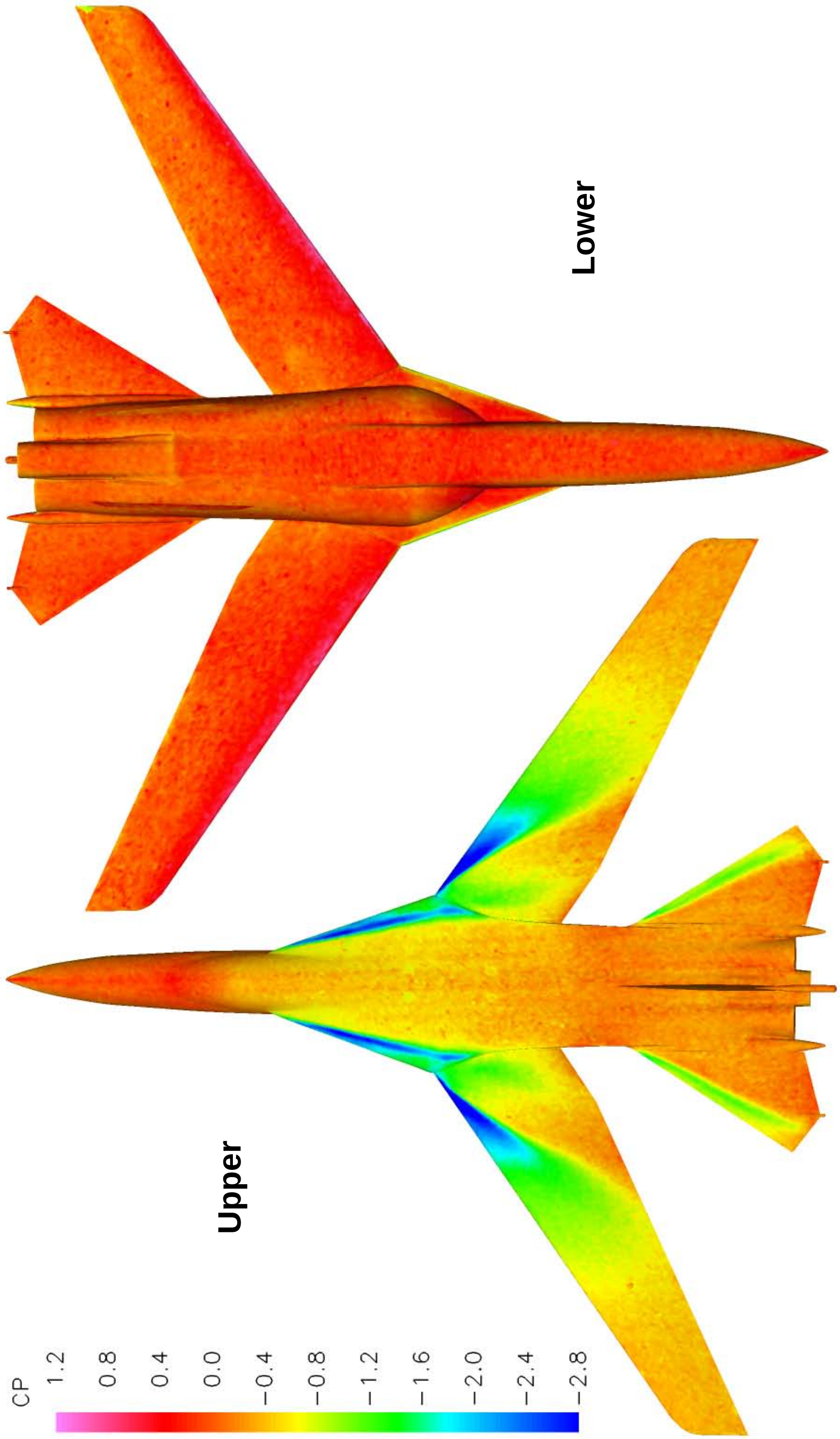


f. Mach Number 1.1.
Figure 15. Concluded.

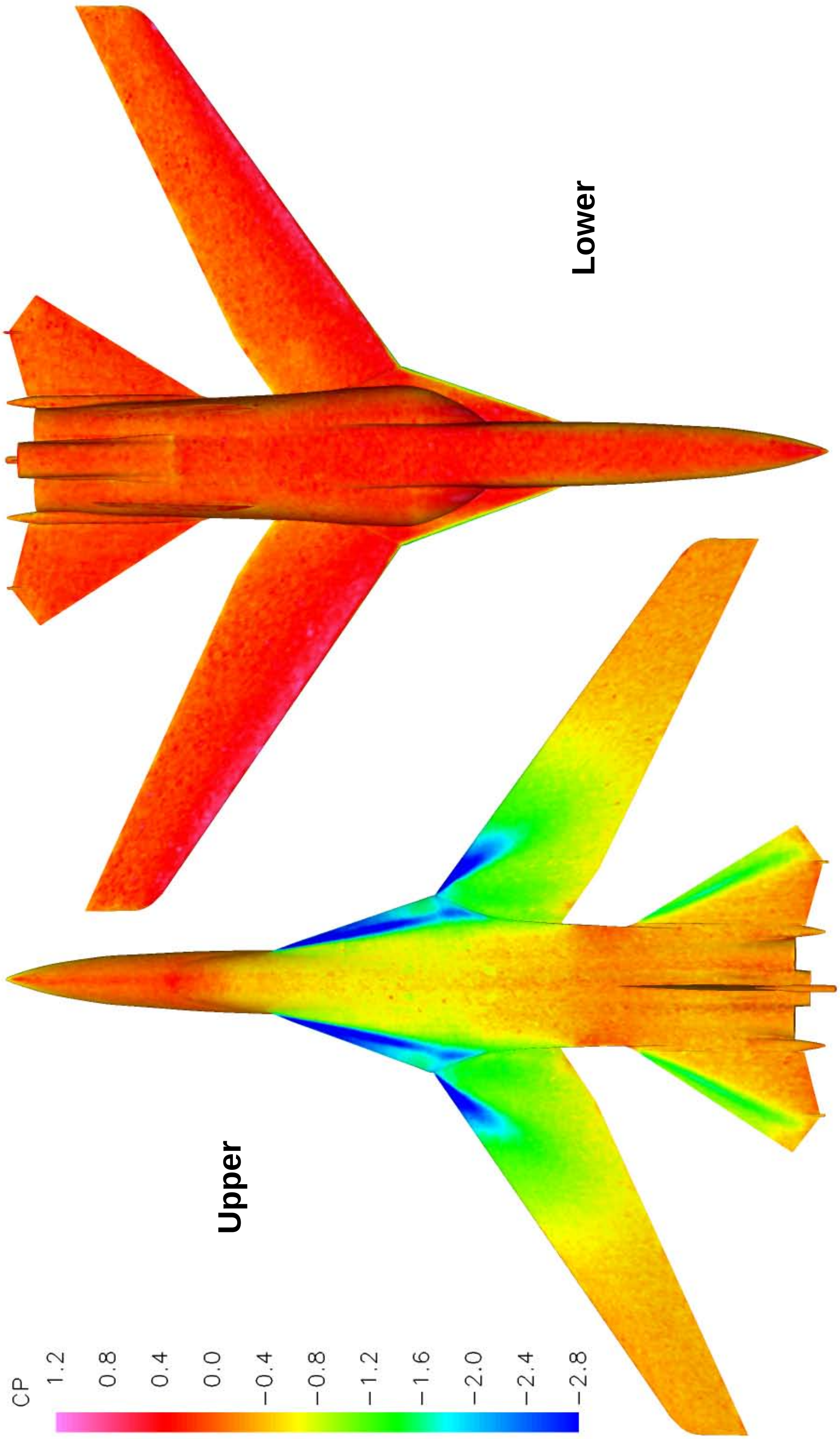


a. Alpha 8 deg.

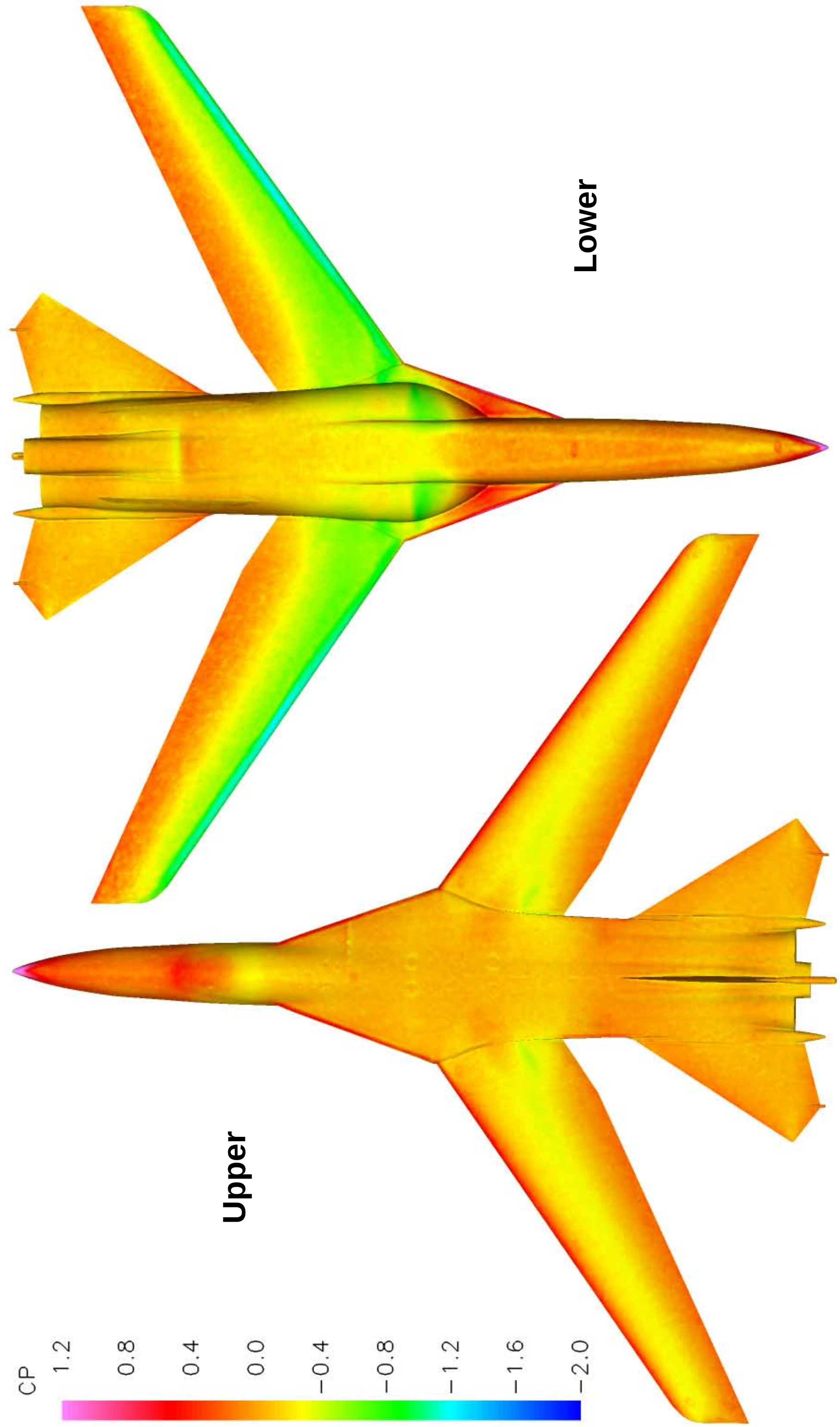
Figure 16. Surface Pressure Distribution at Mach Number 0.4.



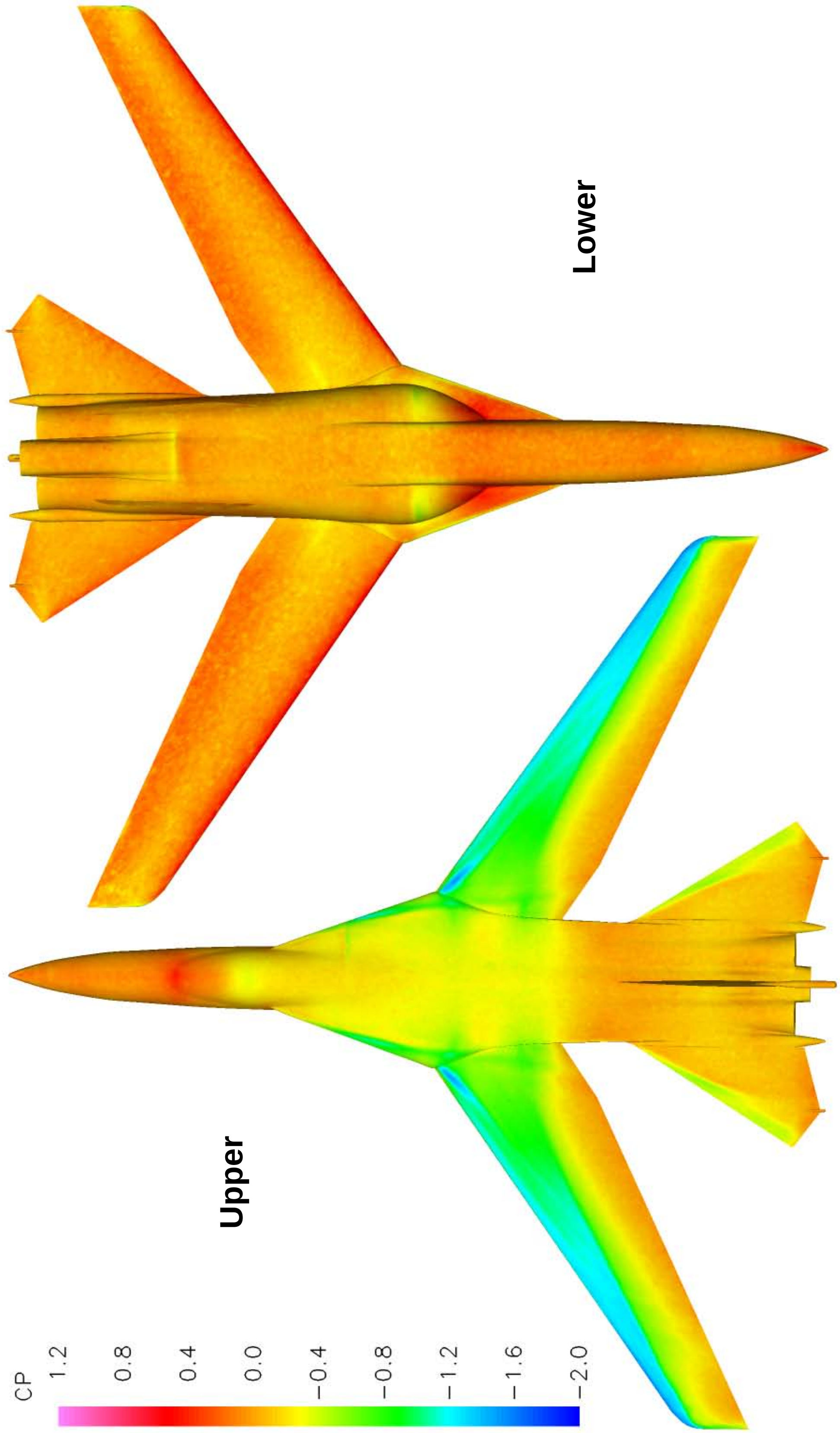
b. Alpha 14 deg.
Figure 16. Continued.



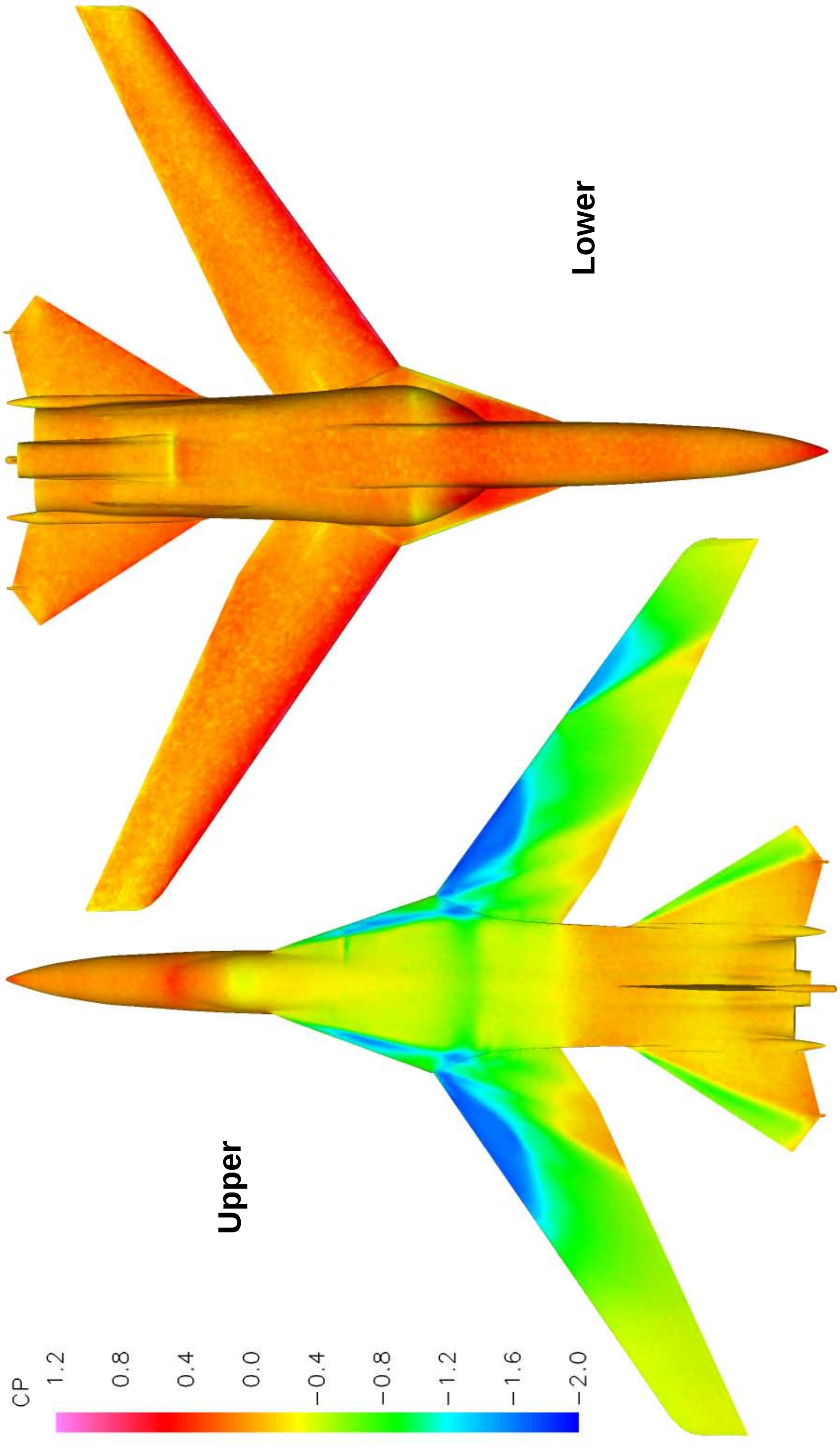
c. Alpha 20 deg.
Figure 16. Concluded



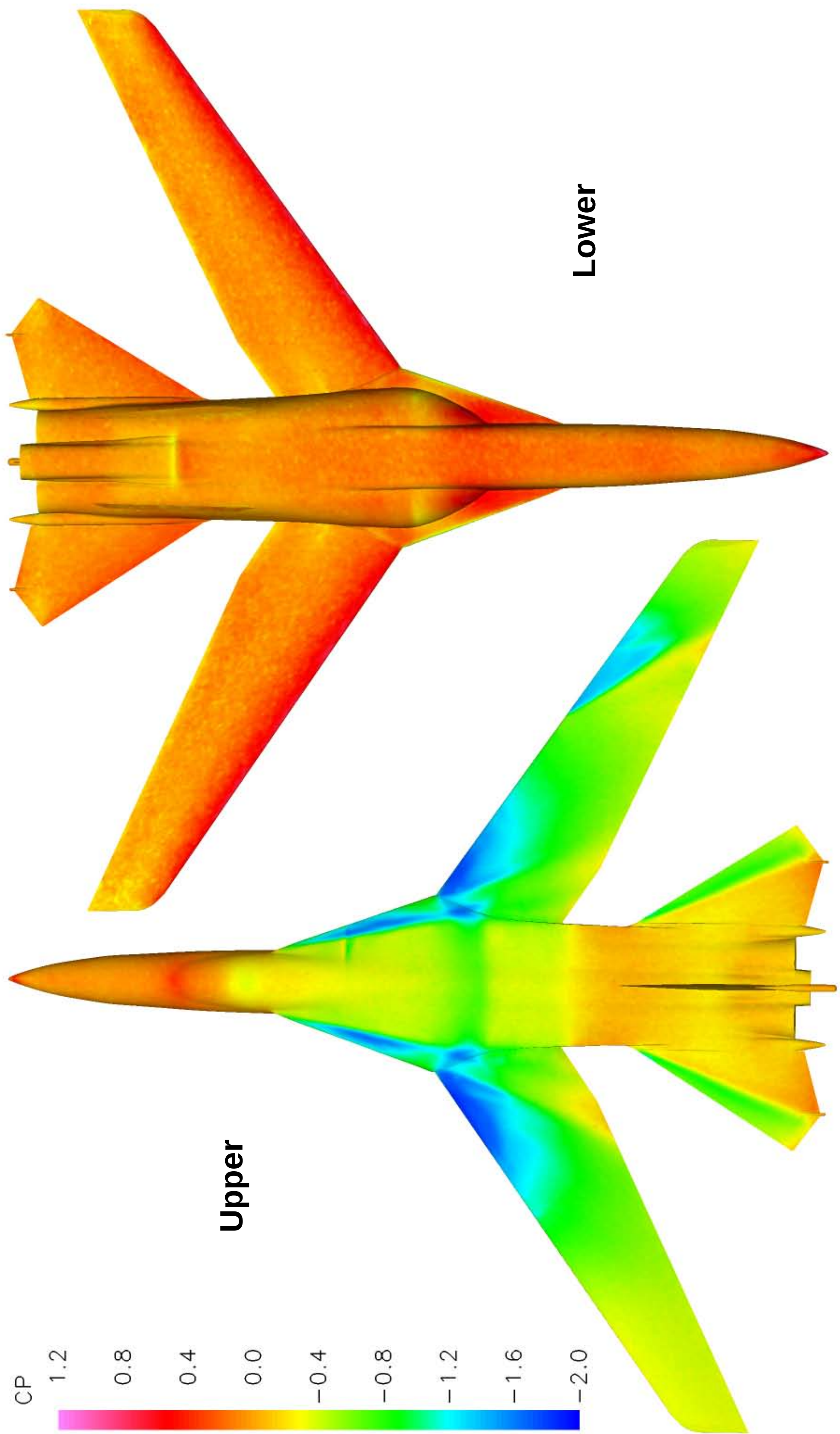
a. Alpha -3 deg.
Figure 17. Surface Pressure Distribution at Mach Number 0.8.



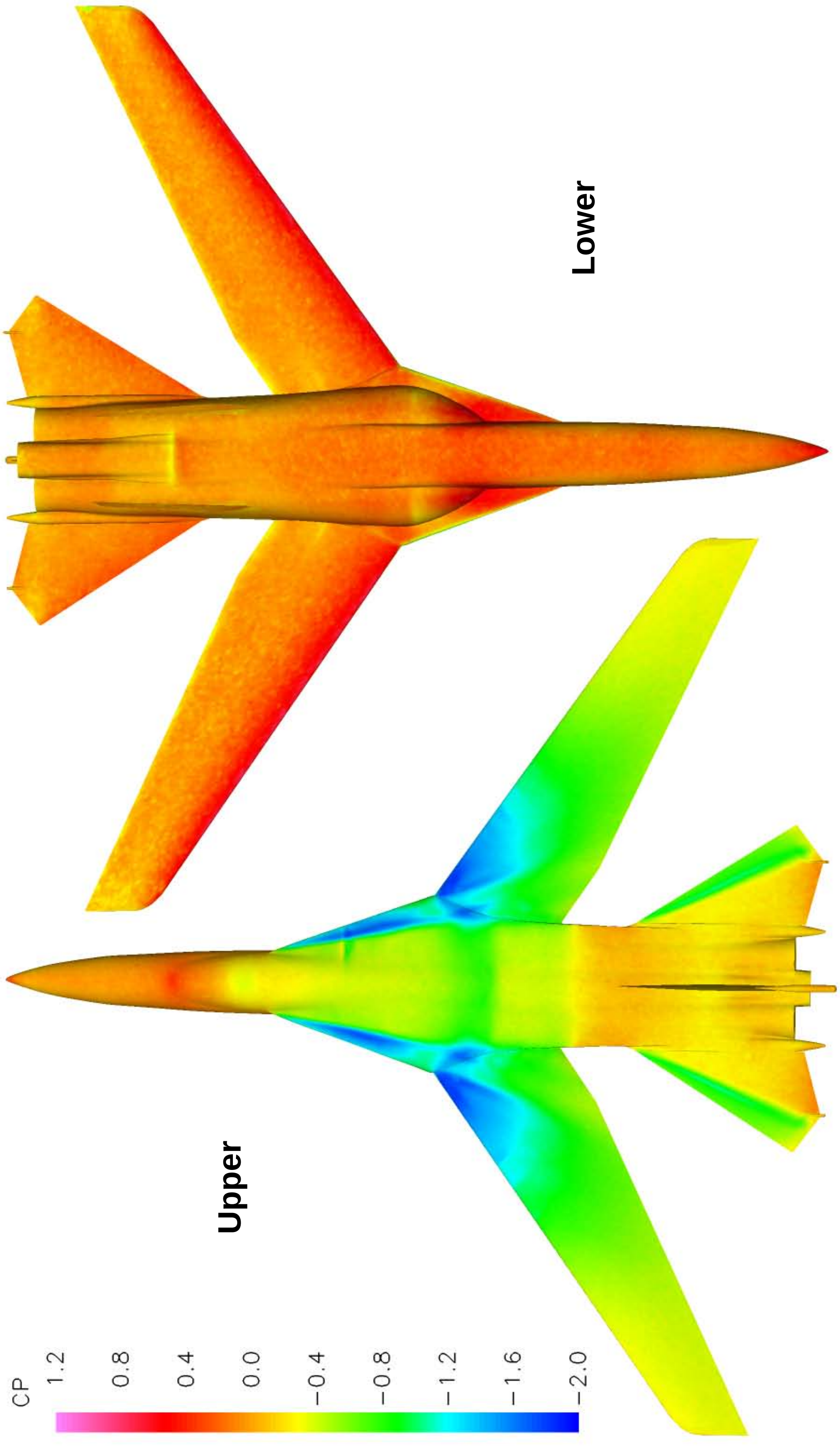
b. Alpha 5 deg.
Figure 17. Continued.



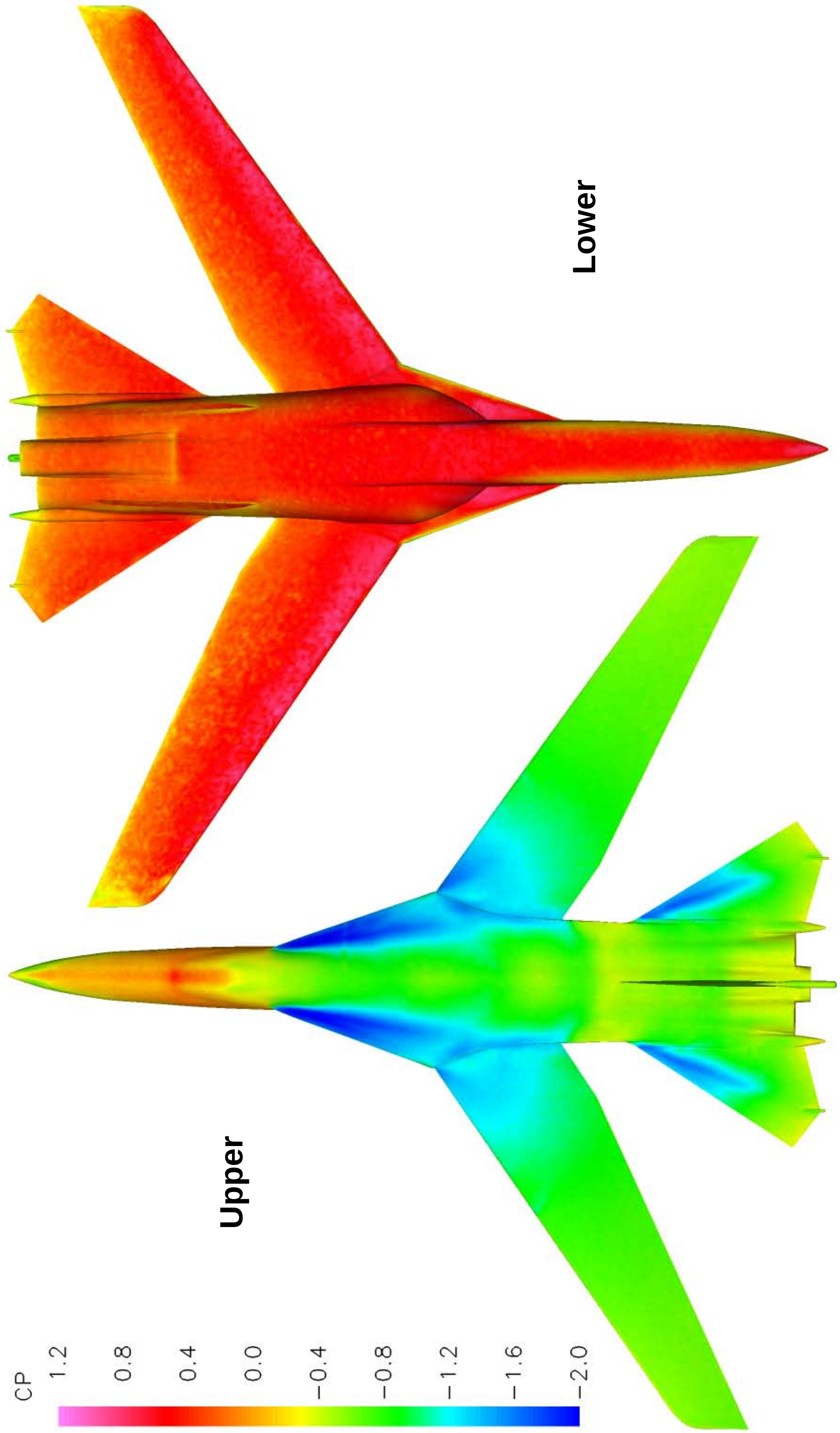
c. Alpha 10 deg.
Figure 17. Continued.



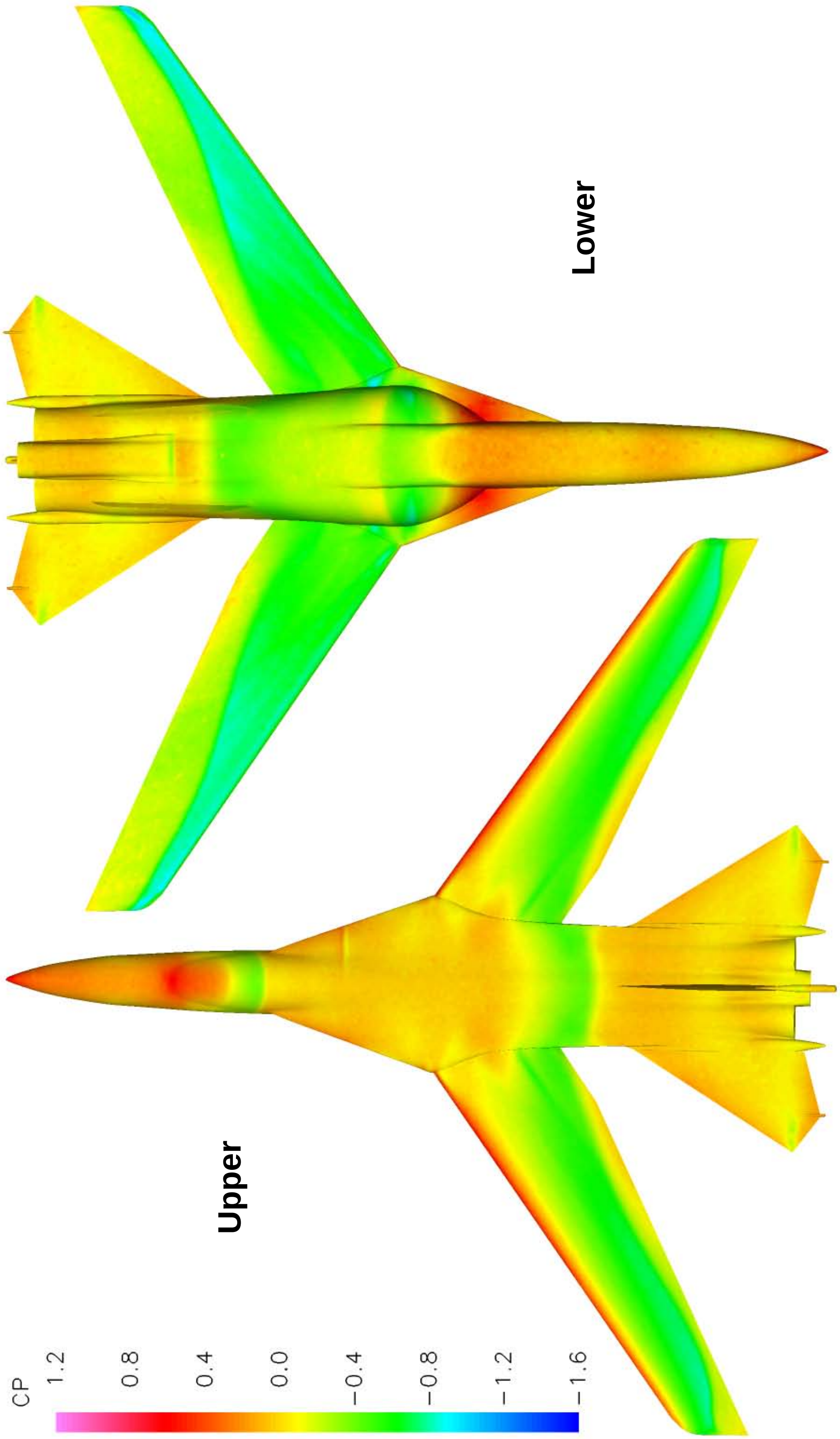
d. Alpha 12 deg.
Figure 17. Continued.



e. Alpha 14 deg.
Figure 17. Continued.

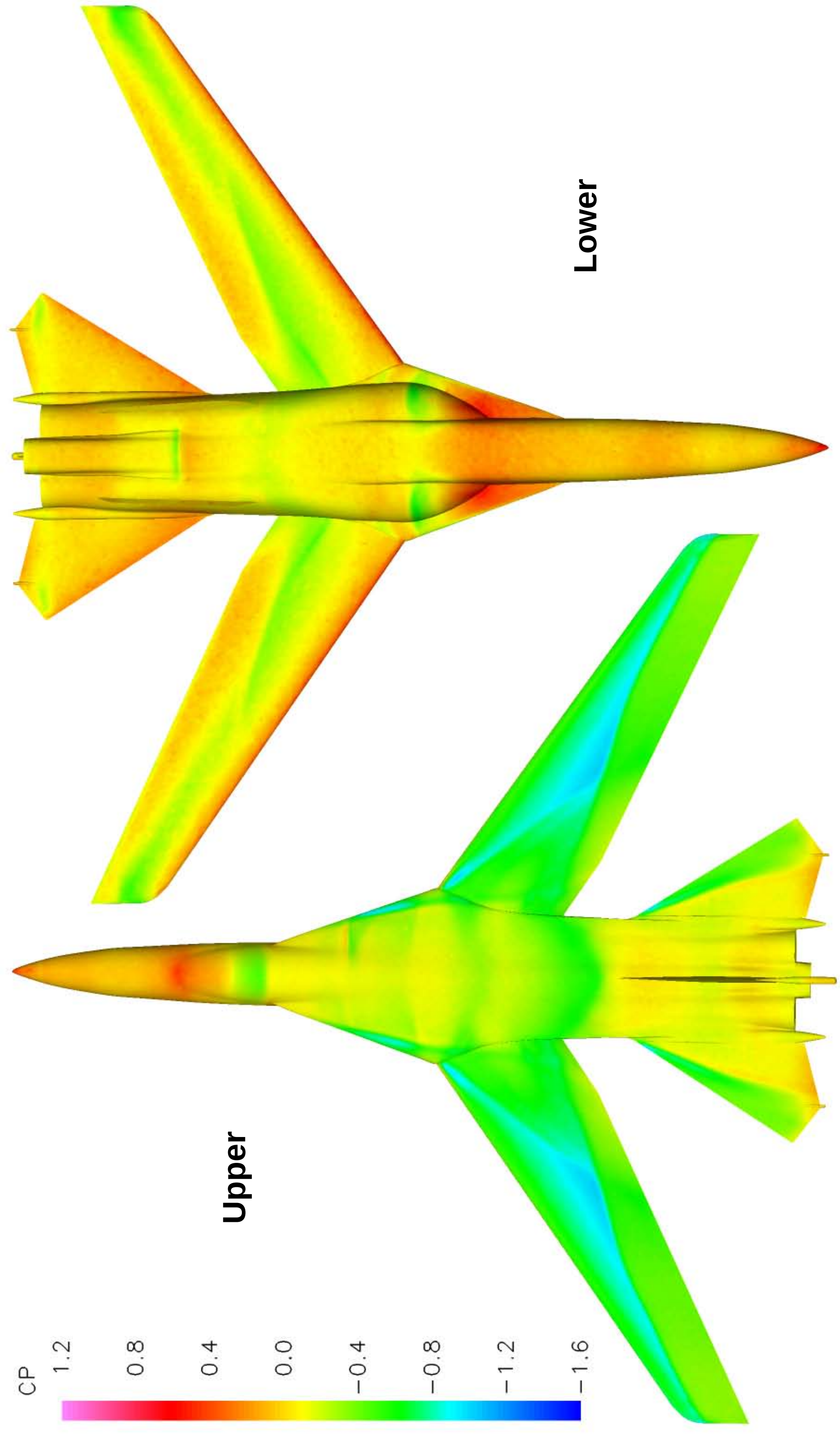


f. Alpha 24 deg.
Figure 17. Concluded.

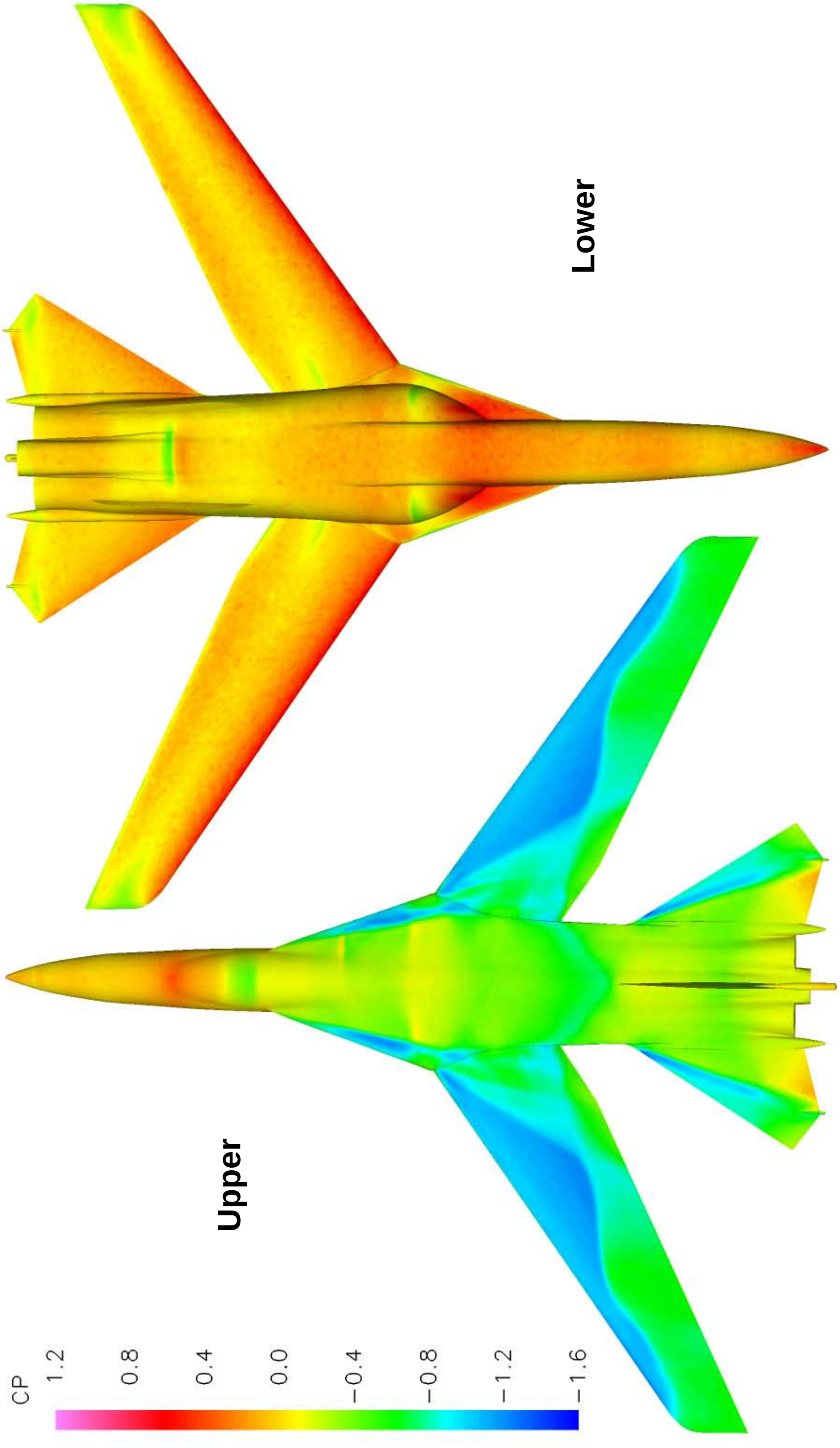


a. Alpha -3 deg.

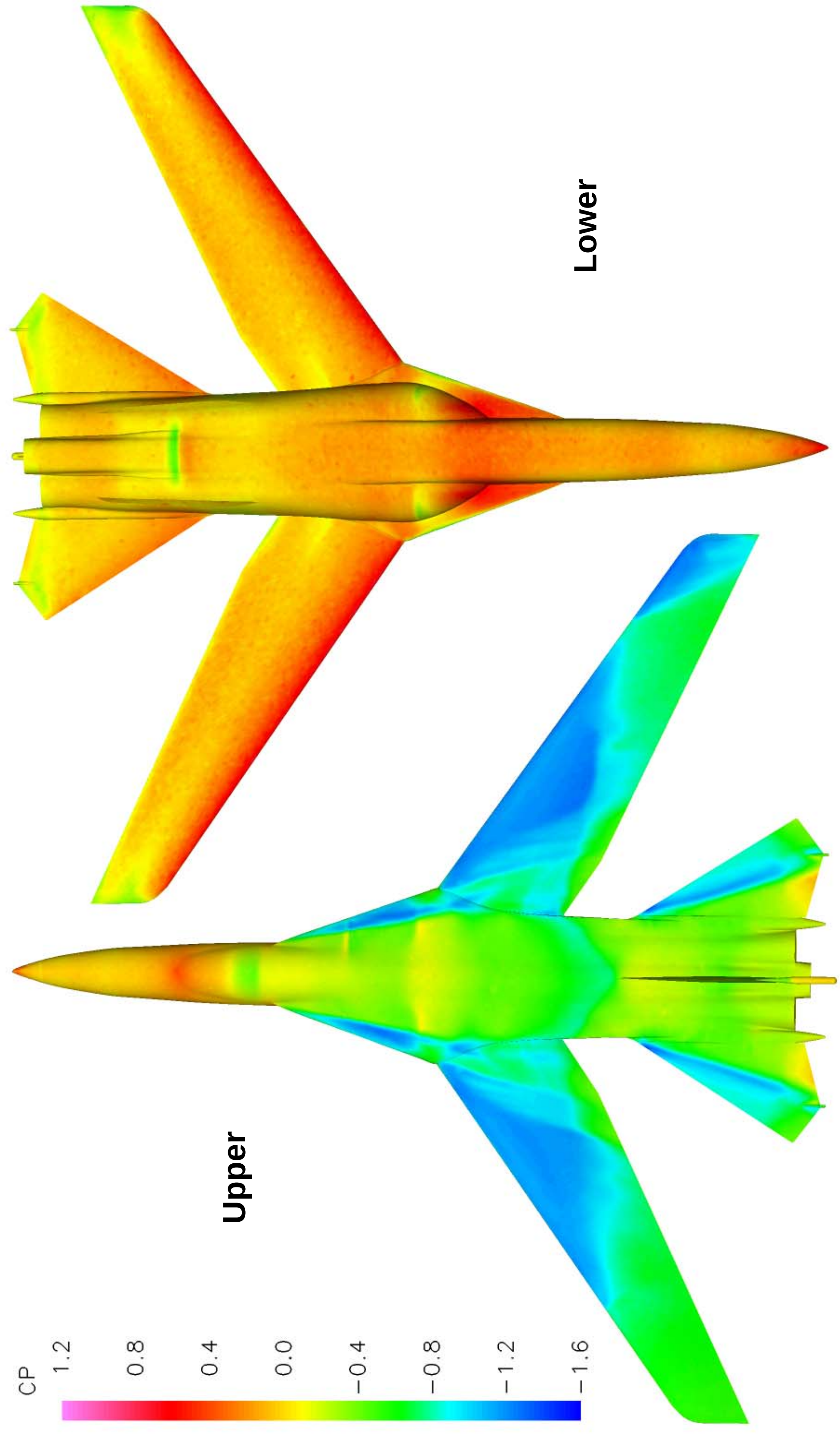
Figure 18. Surface Pressure Distribution at Mach Number 0.95.



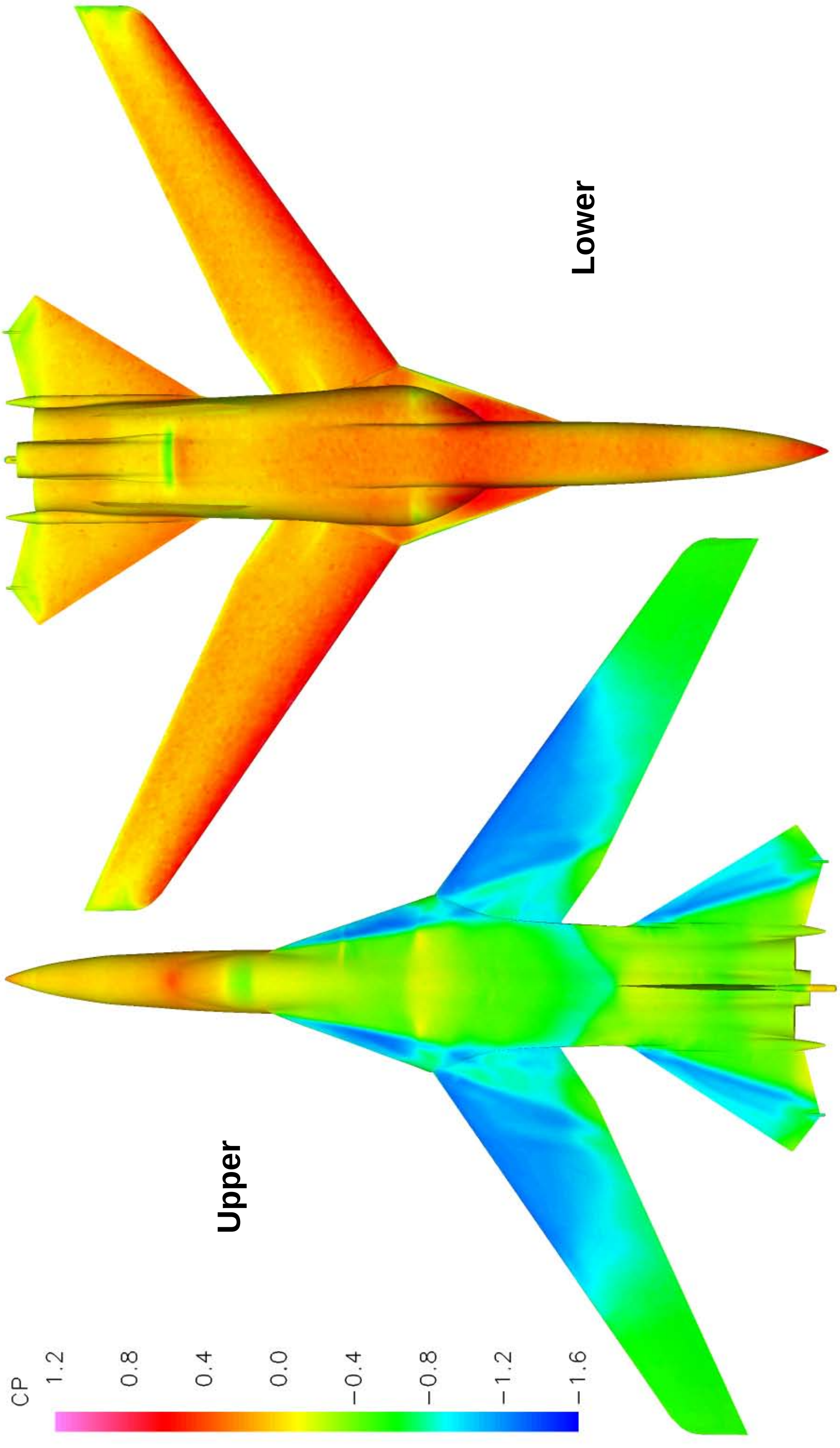
b. Alpha 5 deg.
Figure 18. Continued.



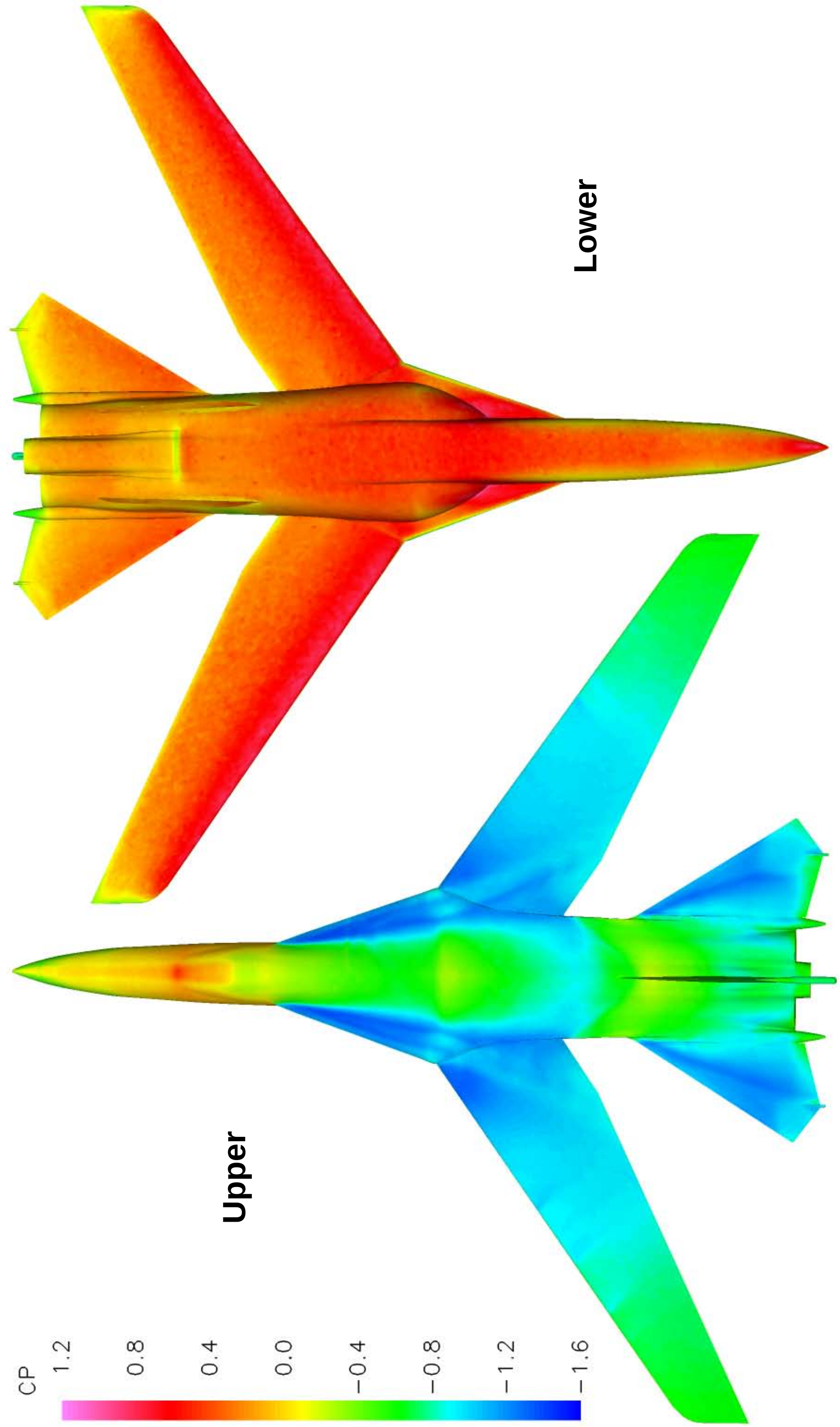
c. Alpha 10 deg.
Figure 18. Continued.



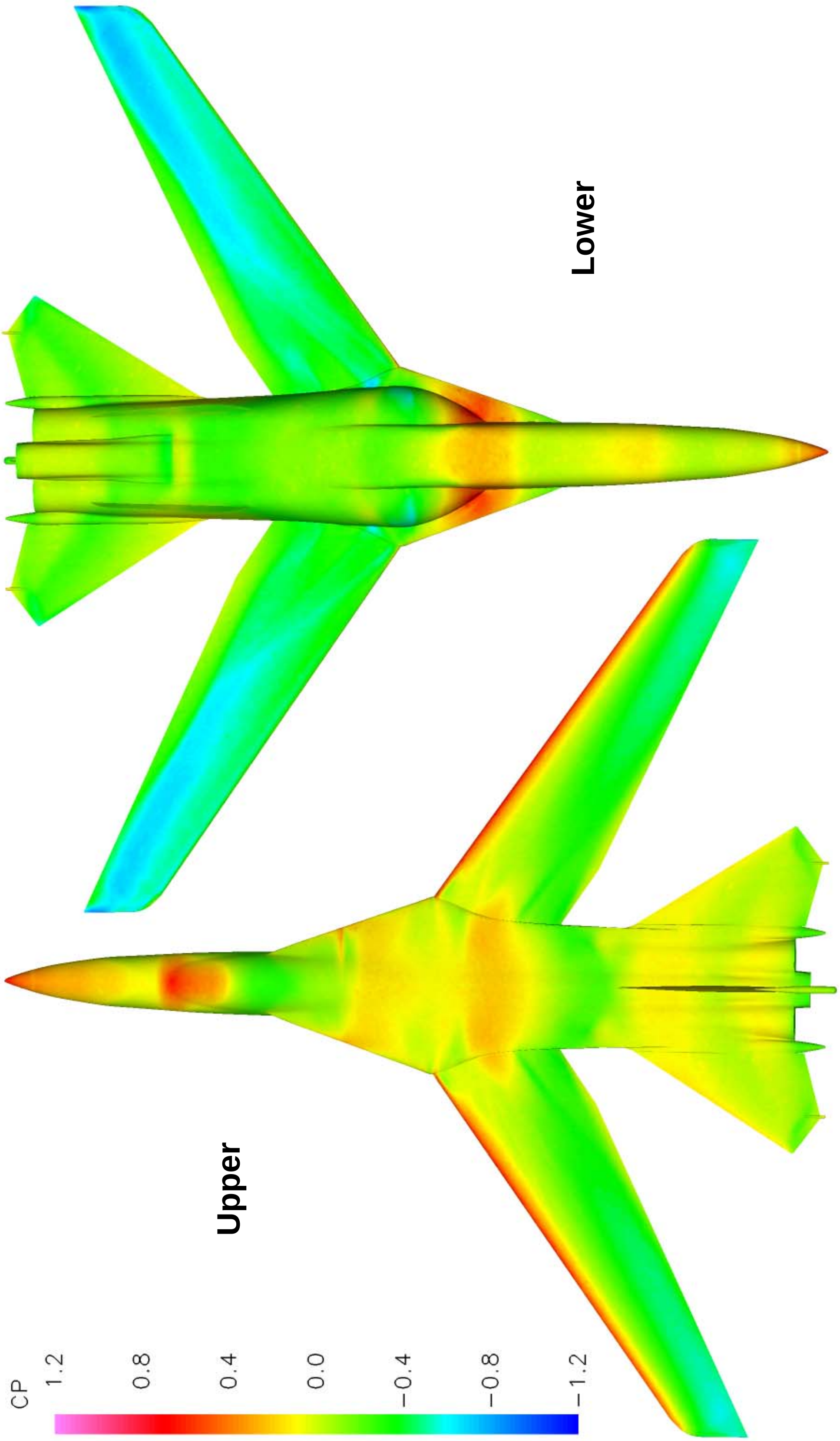
d. Alpha 12 deg.
Figure 18. Continued.



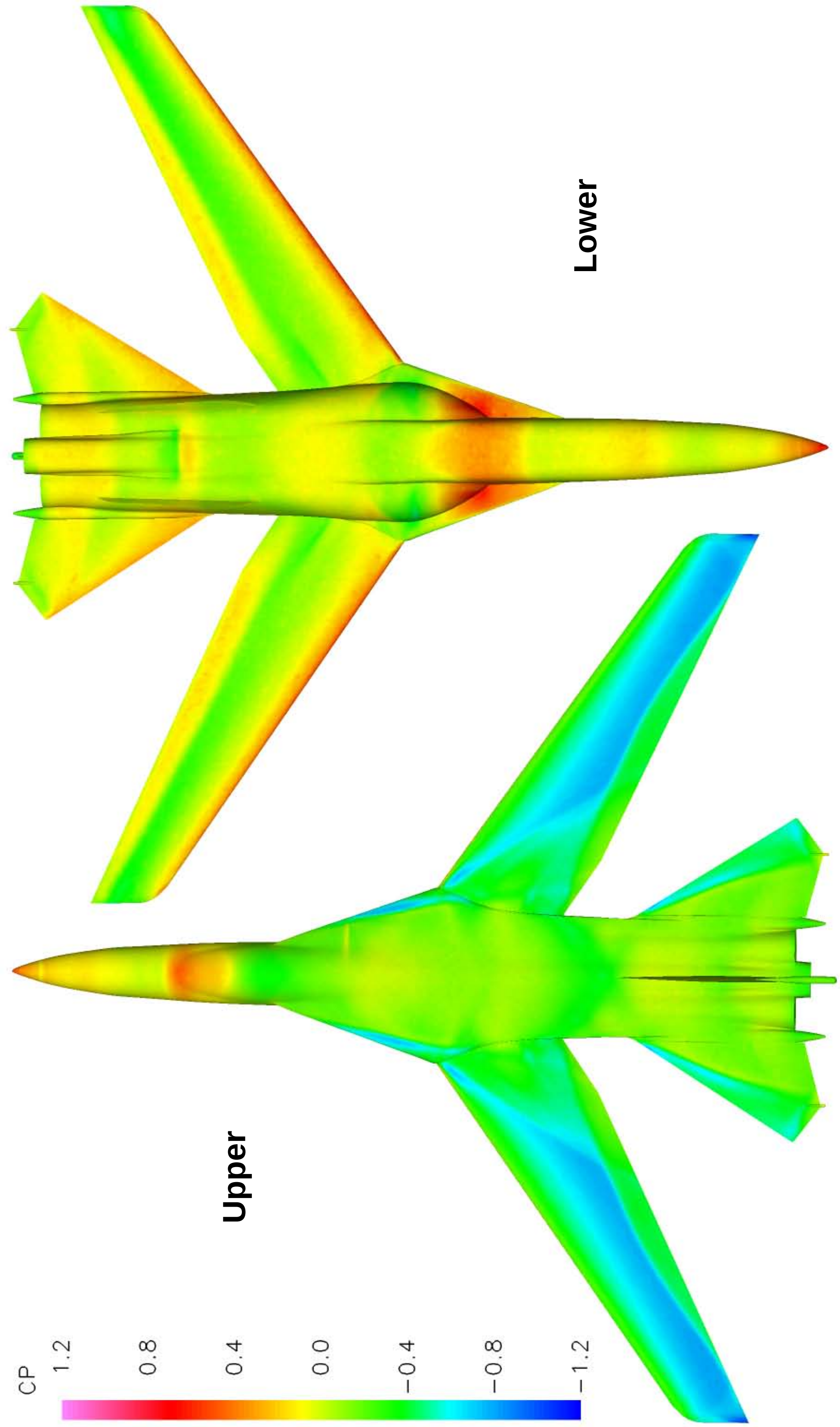
e. Alpha 14 deg.
Figure 18. Continued.



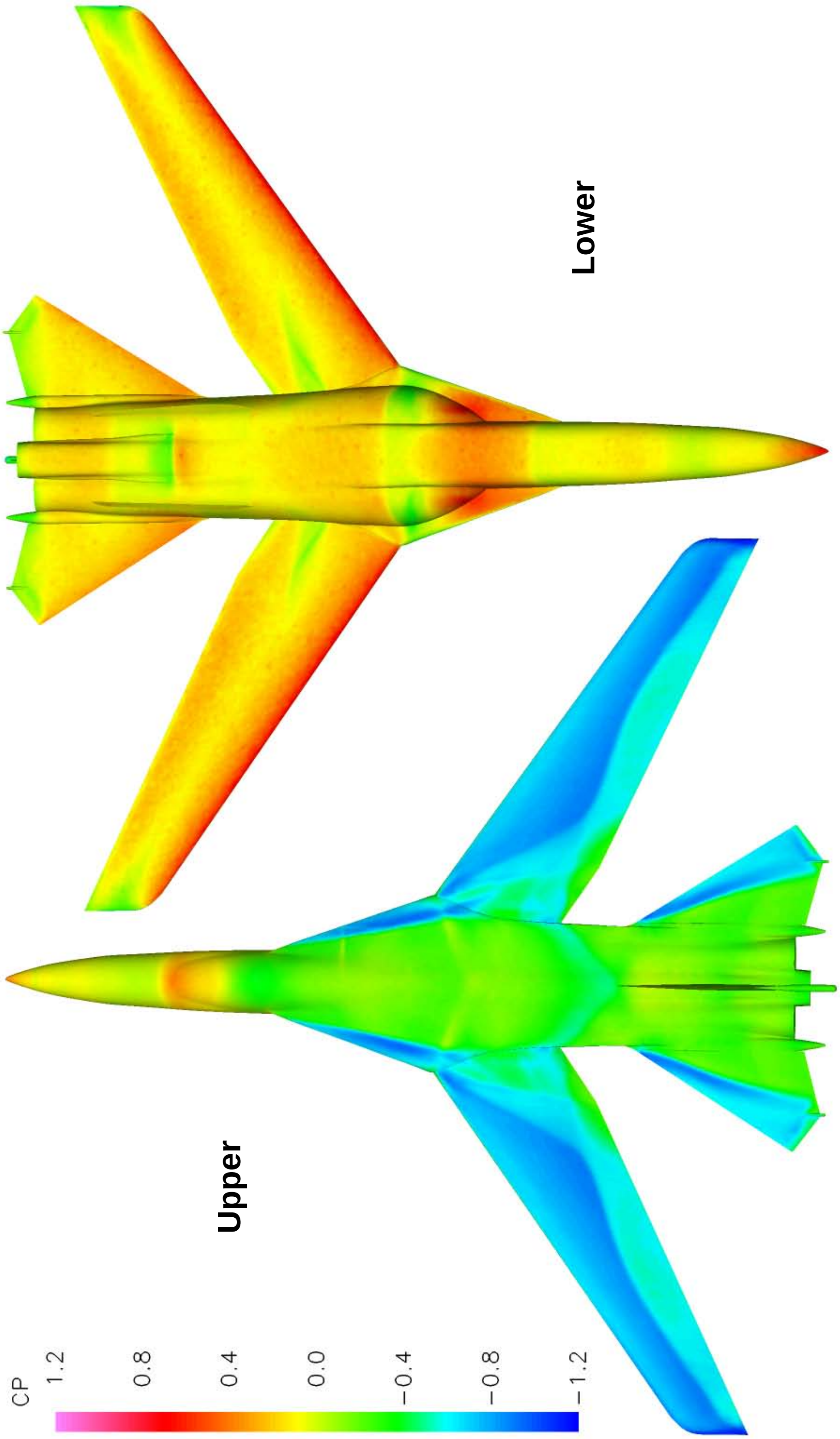
f. Alpha 24 deg.
Figure 18. Concluded.



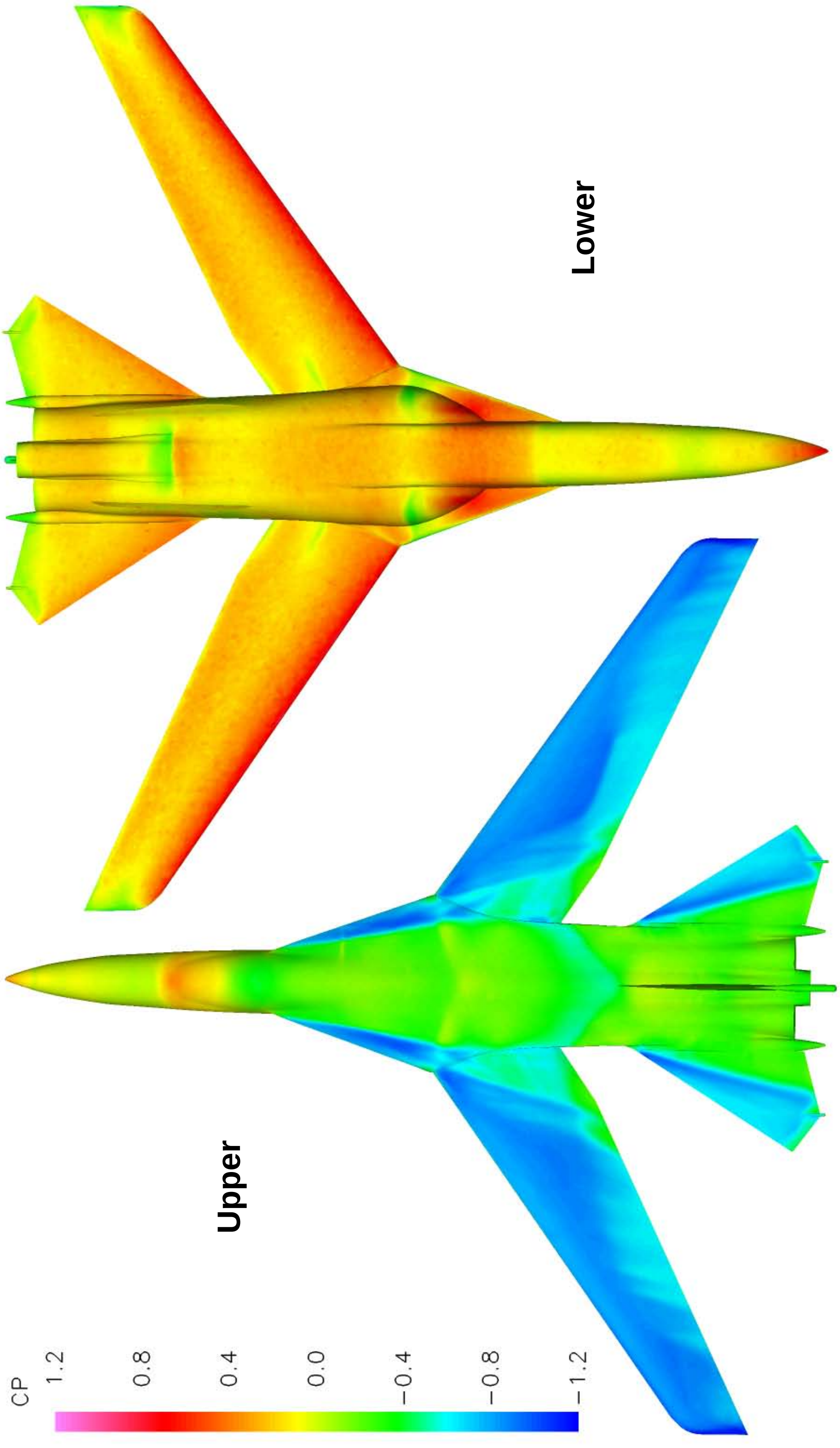
a. Alpha -3 deg.
Figure 19. Surface Pressure Distribution at Mach Number 1.1.



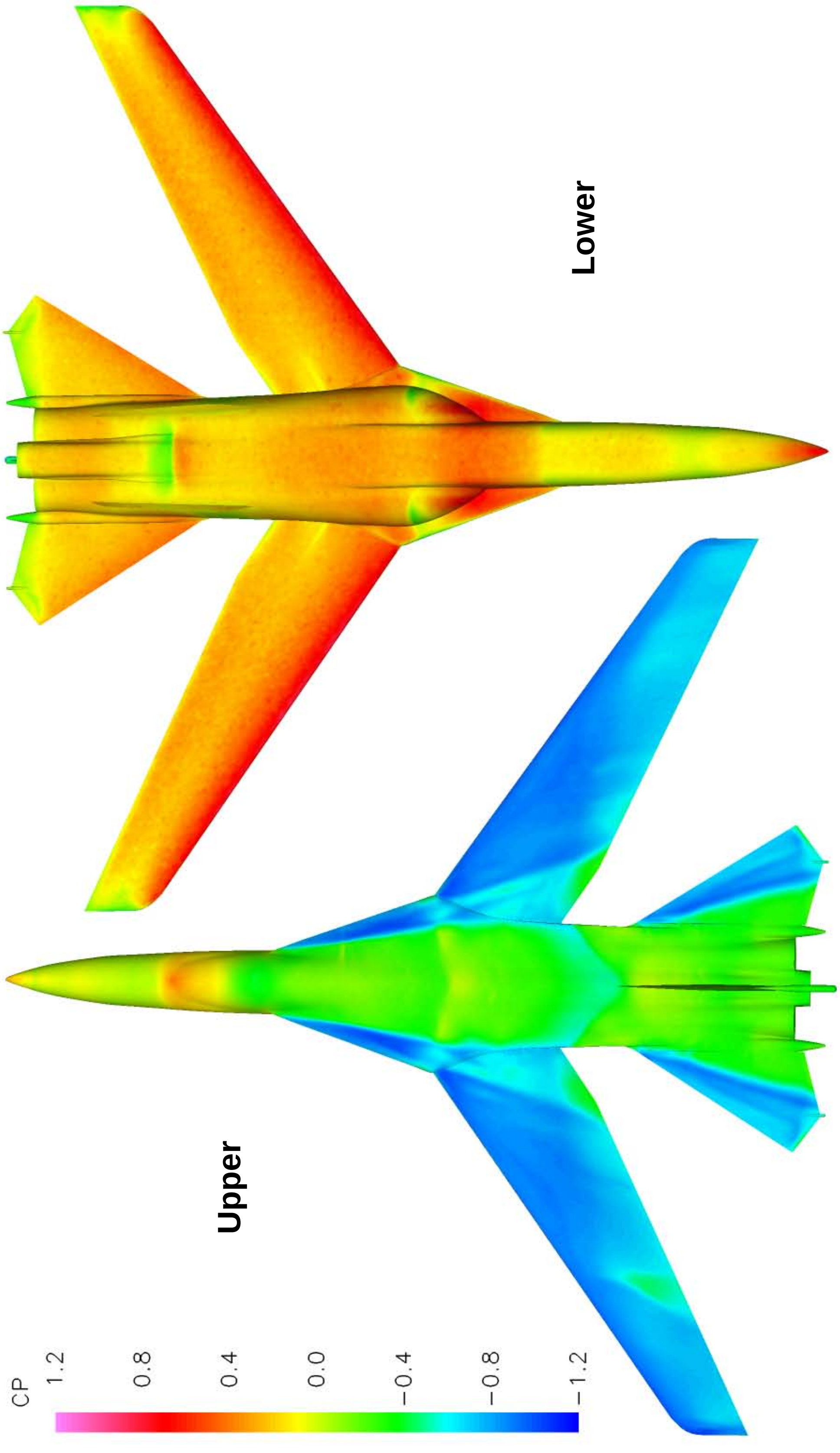
b. Alpha 5 deg.
Figure 19. Continued.



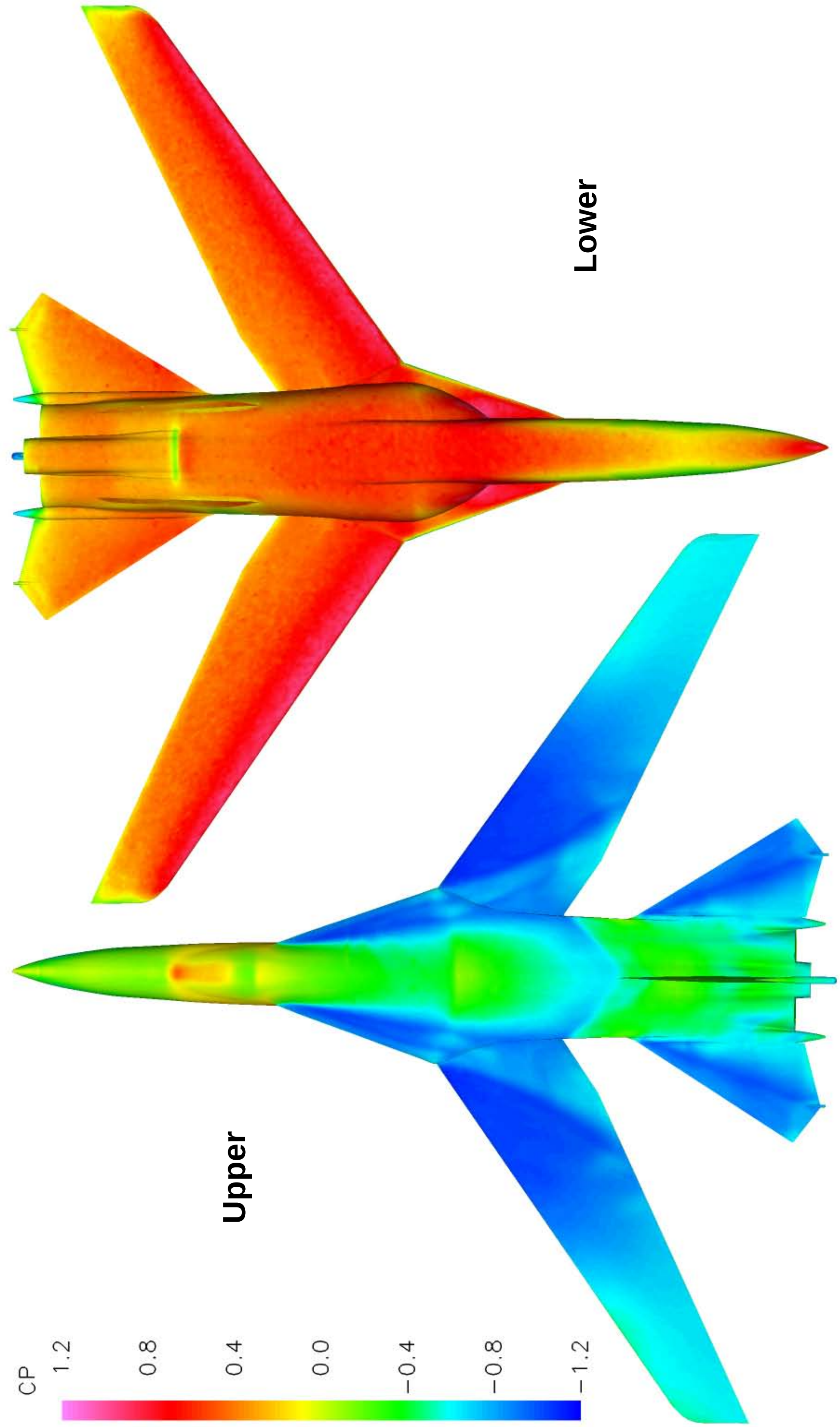
c. Alpha 10 deg.
Figure 19. Continued.



d. Alpha 12 deg.
Figure 19. Continued.



e. Alpha 14 deg.
Figure 19. Continued.



f. Alpha 24 deg.
Figure 19. Concluded.

Table 1. Pressure Orifice Designation and Location
a. Virtual Pressure Orifices

Designation	F.S.	B.L.	W.L.
WRU-1-1	23.241	5.000	9.725
WRU-1-2	23.395	5.000	9.844
WRU-1-3	23.578	5.000	9.911
WRU-1-4	23.770	5.000	9.950
WRU-1-5	23.963	5.000	9.980
WRU-1-6	24.158	5.000	10.003
WRU-1-7	24.352	5.000	10.024
WRU-1-8	24.547	5.000	10.042
WRU-1-9	24.742	5.000	10.058
WRU-1-10	24.938	5.000	10.073
WRU-1-11	25.133	5.000	10.087
WRU-1-12	25.328	5.000	10.100
WRU-1-13	25.524	5.000	10.111
WRU-1-14	25.719	5.000	10.120
WRU-1-15	25.915	5.000	10.126
WRU-1-16	26.111	5.000	10.129
WRU-1-17	26.306	5.000	10.127
WRU-1-18	26.502	5.000	10.125
WRU-1-19	26.698	5.000	10.122
WRU-1-20	26.894	5.000	10.119
WRU-1-21	27.089	5.000	10.115
WRU-1-22	27.285	5.000	10.112
WRU-1-23	27.481	5.000	10.110
WRU-1-24	27.677	5.000	10.105
WRU-1-25	27.872	5.000	10.100
WRU-1-26	28.068	5.000	10.094
WRU-1-27	28.264	5.000	10.087
WRU-1-28	28.459	5.000	10.076
WRU-1-29	28.654	5.000	10.057
WRU-1-30	28.849	5.000	10.035
WRU-1-31	29.043	5.000	10.016
WRU-1-32	29.238	5.000	9.995
WRU-1-33	29.432	5.000	9.971
WRU-1-34	29.627	5.000	9.947
WRU-1-35	29.821	5.000	9.921
WRU-1-36	30.015	5.000	9.895
WRU-1-37	30.208	5.000	9.867
WRU-1-38	30.402	5.000	9.837
WRU-1-39	30.594	5.000	9.801
WRU-1-40	30.786	5.000	9.761
WRU-2-1	25.440	8.125	9.738
WRU-2-2	25.621	8.125	9.818
WRU-2-3	25.811	8.125	9.871
WRU-2-4	26.004	8.125	9.918
WRU-2-5	26.198	8.125	9.957
WRU-2-6	26.393	8.125	9.991
WRU-2-7	26.589	8.125	10.018
WRU-2-8	26.785	8.125	10.041
WRU-2-9	26.982	8.125	10.060
WRU-2-10	27.180	8.125	10.075

Designation	F.S.	B.L.	W.L.
WRU-2-11	27.377	8.125	10.087
WRU-2-12	27.575	8.125	10.097
WRU-2-13	27.773	8.125	10.105
WRU-2-14	27.971	8.125	10.110
WRU-2-15	28.169	8.125	10.112
WRU-2-16	28.367	8.125	10.113
WRU-2-17	28.565	8.125	10.111
WRU-2-18	28.762	8.125	10.106
WRU-2-19	28.960	8.125	10.099
WRU-2-20	29.158	8.125	10.089
WRU-2-21	29.356	8.125	10.078
WRU-2-22	29.553	8.125	10.063
WRU-2-23	29.750	8.125	10.047
WRU-2-24	29.947	8.125	10.029
WRU-2-25	30.144	8.125	10.009
WRU-2-26	30.341	8.125	9.988
WRU-2-27	30.538	8.125	9.966
WRU-2-28	30.734	8.125	9.943
WRU-2-29	30.931	8.125	9.919
WRU-2-30	31.127	8.125	9.895
WRU-2-31	31.324	8.125	9.870
WRU-2-32	31.520	8.125	9.846
WRU-2-33	31.717	8.125	9.822
WRU-2-34	31.913	8.125	9.798
WRU-2-35	32.110	8.125	9.775
WRU-2-36	32.306	8.125	9.752
WRU-2-37	32.503	8.125	9.731
WRU-3-1	28.157	12.000	9.760
WRU-3-2	28.343	12.000	9.833
WRU-3-3	28.536	12.000	9.884
WRU-3-4	28.732	12.000	9.927
WRU-3-5	28.929	12.000	9.963
WRU-3-6	29.127	12.000	9.993
WRU-3-7	29.325	12.000	10.017
WRU-3-8	29.524	12.000	10.035
WRU-3-9	29.724	12.000	10.050
WRU-3-10	29.924	12.000	10.062
WRU-3-11	30.124	12.000	10.070
WRU-3-12	30.324	12.000	10.076
WRU-3-13	30.524	12.000	10.078
WRU-3-14	30.724	12.000	10.078
WRU-3-15	30.924	12.000	10.075
WRU-3-16	31.124	12.000	10.070
WRU-3-17	31.324	12.000	10.061
WRU-3-18	31.524	12.000	10.050
WRU-3-19	31.724	12.000	10.036
WRU-3-20	31.923	12.000	10.019
WRU-3-21	32.122	12.000	10.001
WRU-3-22	32.321	12.000	9.981
WRU-3-23	32.520	12.000	9.959

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WRU-3-24	32.719	12.000	9.936
WRU-3-25	32.918	12.000	9.912
WRU-3-26	33.116	12.000	9.888
WRU-3-27	33.315	12.000	9.864
WRU-3-28	33.514	12.000	9.839
WRU-3-29	33.712	12.000	9.815
WRU-3-30	33.911	12.000	9.791
WRU-3-31	34.110	12.000	9.768
WRU-3-32	34.309	12.000	9.747
WRU-4-1	31.049	16.125	9.782
WRU-4-2	31.239	16.125	9.848
WRU-4-3	31.434	16.125	9.895
WRU-4-4	31.631	16.125	9.934
WRU-4-5	31.829	16.125	9.965
WRU-4-6	32.029	16.125	9.990
WRU-4-7	32.229	16.125	10.009
WRU-4-8	32.429	16.125	10.023
WRU-4-9	32.630	16.125	10.033
WRU-4-10	32.831	16.125	10.040
WRU-4-11	33.032	16.125	10.042
WRU-4-12	33.232	16.125	10.042
WRU-4-13	33.433	16.125	10.038
WRU-4-14	33.634	16.125	10.030
WRU-4-15	33.835	16.125	10.020
WRU-4-16	34.035	16.125	10.006
WRU-4-17	34.235	16.125	9.990
WRU-4-18	34.435	16.125	9.971
WRU-4-19	34.635	16.125	9.950
WRU-4-20	34.835	16.125	9.928
WRU-4-21	35.035	16.125	9.905
WRU-4-22	35.234	16.125	9.881
WRU-4-23	35.434	16.125	9.857
WRU-4-24	35.633	16.125	9.832
WRU-4-25	35.832	16.125	9.808
WRU-4-26	36.032	16.125	9.785
WRU-4-27	36.232	16.125	9.764
WRU-5-1	33.817	20.000	9.822
WRU-5-2	34.013	20.000	9.873
WRU-5-3	34.211	20.000	9.914
WRU-5-4	34.411	20.000	9.946
WRU-5-5	34.611	20.000	9.970
WRU-5-6	34.813	20.000	9.988
WRU-5-7	35.015	20.000	9.999
WRU-5-8	35.217	20.000	10.006
WRU-5-9	35.419	20.000	10.009
WRU-5-10	35.622	20.000	10.007
WRU-5-11	35.824	20.000	10.001
WRU-5-12	36.026	20.000	9.990
WRU-5-13	36.228	20.000	9.977
WRU-5-14	36.429	20.000	9.960

Designation	F.S.	B.L.	W.L.
WRU-5-15	36.631	20.000	9.941
WRU-5-16	36.832	20.000	9.919
WRU-5-17	37.033	20.000	9.897
WRU-5-18	37.234	20.000	9.873
WRU-5-19	37.435	20.000	9.849
WRU-5-20	37.636	20.000	9.825
WRU-5-21	37.837	20.000	9.801
WRU-5-22	38.038	20.000	9.779
WRU-6-1	35.924	23.000	9.834
WRU-6-2	36.115	23.000	9.879
WRU-6-3	36.308	23.000	9.915
WRU-6-4	36.503	23.000	9.942
WRU-6-5	36.698	23.000	9.962
WRU-6-6	36.895	23.000	9.975
WRU-6-7	37.091	23.000	9.981
WRU-6-8	37.287	23.000	9.982
WRU-6-9	37.484	23.000	9.978
WRU-6-10	37.680	23.000	9.970
WRU-6-11	37.876	23.000	9.958
WRU-6-12	38.072	23.000	9.942
WRU-6-13	38.268	23.000	9.923
WRU-6-14	38.463	23.000	9.903
WRU-6-15	38.659	23.000	9.881
WRU-6-16	38.854	23.000	9.858
WRU-6-17	39.049	23.000	9.835
WRU-6-18	39.244	23.000	9.813
WRU-6-19	39.440	23.000	9.791
WRL-1-1	23.241	5.000	9.563
WRL-1-2	23.395	5.000	9.484
WRL-1-3	23.578	5.000	9.447
WRL-1-4	23.770	5.000	9.426
WRL-1-5	23.963	5.000	9.411
WRL-1-6	24.158	5.000	9.397
WRL-1-7	24.352	5.000	9.384
WRL-1-8	24.547	5.000	9.373
WRL-1-9	24.742	5.000	9.365
WRL-1-10	24.938	5.000	9.357
WRL-1-11	25.133	5.000	9.351
WRL-1-12	25.328	5.000	9.346
WRL-1-13	25.524	5.000	9.344
WRL-1-14	25.719	5.000	9.344
WRL-1-15	25.915	5.000	9.345
WRL-1-16	26.111	5.000	9.348
WRL-1-17	26.306	5.000	9.351
WRL-1-18	26.502	5.000	9.357
WRL-1-19	26.698	5.000	9.363
WRL-1-20	26.894	5.000	9.371
WRL-1-21	27.089	5.000	9.381
WRL-1-22	27.285	5.000	9.392
WRL-1-23	27.481	5.000	9.402

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WRL-1-24	27.677	5.000	9.415
WRL-1-25	27.872	5.000	9.426
WRL-1-26	28.068	5.000	9.447
WRL-1-27	28.264	5.000	9.471
WRL-1-28	28.459	5.000	9.493
WRL-1-29	28.654	5.000	9.517
WRL-1-30	28.849	5.000	9.543
WRL-1-31	29.043	5.000	9.569
WRL-1-32	29.238	5.000	9.595
WRL-1-33	29.432	5.000	9.620
WRL-1-34	29.627	5.000	9.643
WRL-1-35	29.821	5.000	9.664
WRL-1-36	30.015	5.000	9.682
WRL-1-37	30.208	5.000	9.696
WRL-1-38	30.402	5.000	9.709
WRL-1-39	30.594	5.000	9.722
WRL-1-40	30.786	5.000	9.734
WRL-2-1	25.266	7.875	9.596
WRL-2-2	25.448	7.875	9.537
WRL-2-3	25.640	7.875	9.504
WRL-2-4	25.834	7.875	9.477
WRL-2-5	26.029	7.875	9.454
WRL-2-6	26.226	7.875	9.436
WRL-2-7	26.423	7.875	9.422
WRL-2-8	26.622	7.875	9.411
WRL-2-9	26.820	7.875	9.403
WRL-2-10	27.019	7.875	9.397
WRL-2-11	27.218	7.875	9.394
WRL-2-12	27.418	7.875	9.393
WRL-2-13	27.617	7.875	9.394
WRL-2-14	27.817	7.875	9.396
WRL-2-15	28.016	7.875	9.400
WRL-2-16	28.216	7.875	9.406
WRL-2-17	28.415	7.875	9.413
WRL-2-18	28.615	7.875	9.423
WRL-2-19	28.814	7.875	9.434
WRL-2-20	29.013	7.875	9.447
WRL-2-21	29.213	7.875	9.461
WRL-2-22	29.412	7.875	9.478
WRL-2-23	29.611	7.875	9.496
WRL-2-24	29.809	7.875	9.514
WRL-2-25	30.008	7.875	9.534
WRL-2-26	30.206	7.875	9.555
WRL-2-27	30.405	7.875	9.576
WRL-2-28	30.603	7.875	9.597
WRL-2-29	30.801	7.875	9.617
WRL-2-30	30.999	7.875	9.638
WRL-2-31	31.197	7.875	9.657
WRL-2-32	31.395	7.875	9.675
WRL-2-33	31.593	7.875	9.691

Designation	F.S.	B.L.	W.L.
WRL-2-34	31.791	7.875	9.704
WRL-2-35	31.989	7.875	9.714
WRL-2-36	32.187	7.875	9.719
WRL-2-37	32.386	7.875	9.721
WRL-3-1	28.157	12.000	9.627
WRL-3-2	28.343	12.000	9.570
WRL-3-3	28.536	12.000	9.540
WRL-3-4	28.732	12.000	9.516
WRL-3-5	28.929	12.000	9.497
WRL-3-6	29.127	12.000	9.482
WRL-3-7	29.325	12.000	9.471
WRL-3-8	29.524	12.000	9.463
WRL-3-9	29.724	12.000	9.457
WRL-3-10	29.924	12.000	9.455
WRL-3-11	30.124	12.000	9.454
WRL-3-12	30.324	12.000	9.456
WRL-3-13	30.524	12.000	9.459
WRL-3-14	30.724	12.000	9.465
WRL-3-15	30.924	12.000	9.473
WRL-3-16	31.124	12.000	9.482
WRL-3-17	31.324	12.000	9.495
WRL-3-18	31.524	12.000	9.509
WRL-3-19	31.724	12.000	9.525
WRL-3-20	31.923	12.000	9.543
WRL-3-21	32.122	12.000	9.563
WRL-3-22	32.321	12.000	9.583
WRL-3-23	32.520	12.000	9.604
WRL-3-24	32.719	12.000	9.625
WRL-3-25	32.918	12.000	9.646
WRL-3-26	33.116	12.000	9.666
WRL-3-27	33.315	12.000	9.686
WRL-3-28	33.514	12.000	9.703
WRL-3-29	33.712	12.000	9.717
WRL-3-30	33.911	12.000	9.729
WRL-3-31	34.110	12.000	9.735
WRL-3-32	34.309	12.000	9.737
WRL-4-1	30.899	15.875	9.645
WRL-4-2	31.094	15.875	9.598
WRL-4-3	31.294	15.875	9.572
WRL-4-4	31.494	15.875	9.552
WRL-4-5	31.695	15.875	9.537
WRL-4-6	31.896	15.875	9.525
WRL-4-7	32.097	15.875	9.518
WRL-4-8	32.298	15.875	9.513
WRL-4-9	32.500	15.875	9.511
WRL-4-10	32.701	15.875	9.512
WRL-4-11	32.902	15.875	9.515
WRL-4-12	33.104	15.875	9.521
WRL-4-13	33.305	15.875	9.529
WRL-4-14	33.506	15.875	9.541

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WRL-4-15	33.707	15.875	9.554
WRL-4-16	33.908	15.875	9.571
WRL-4-17	34.108	15.875	9.589
WRL-4-18	34.309	15.875	9.609
WRL-4-19	34.509	15.875	9.630
WRL-4-20	34.709	15.875	9.652
WRL-4-21	34.909	15.875	9.673
WRL-4-22	35.110	15.875	9.694
WRL-4-23	35.310	15.875	9.713
WRL-4-24	35.511	15.875	9.729
WRL-4-25	35.712	15.875	9.742
WRL-4-26	35.913	15.875	9.750
WRL-4-27	36.114	15.875	9.753
WRL-5-1	33.817	20.000	9.665
WRL-5-2	34.013	20.000	9.632
WRL-5-3	34.211	20.000	9.612
WRL-5-4	34.411	20.000	9.596
WRL-5-5	34.611	20.000	9.585
WRL-5-6	34.813	20.000	9.577
WRL-5-7	35.015	20.000	9.573
WRL-5-8	35.217	20.000	9.572
WRL-5-9	35.419	20.000	9.575
WRL-5-10	35.622	20.000	9.580
WRL-5-11	35.824	20.000	9.590
WRL-5-12	36.026	20.000	9.602
WRL-5-13	36.228	20.000	9.619
WRL-5-14	36.429	20.000	9.638
WRL-5-15	36.631	20.000	9.659
WRL-5-16	36.832	20.000	9.681
WRL-5-17	37.033	20.000	9.702
WRL-5-18	37.234	20.000	9.723
WRL-5-19	37.435	20.000	9.741
WRL-5-20	37.636	20.000	9.756
WRL-5-21	37.837	20.000	9.766
WRL-5-22	38.038	20.000	9.770
WRL-6-1	35.924	23.000	9.697
WRL-6-2	36.115	23.000	9.662
WRL-6-3	36.308	23.000	9.645
WRL-6-4	36.503	23.000	9.632
WRL-6-5	36.698	23.000	9.623
WRL-6-6	36.895	23.000	9.618
WRL-6-7	37.091	23.000	9.616
WRL-6-8	37.287	23.000	9.618
WRL-6-9	37.484	23.000	9.625
WRL-6-10	37.680	23.000	9.635
WRL-6-11	37.876	23.000	9.650
WRL-6-12	38.072	23.000	9.669
WRL-6-13	38.268	23.000	9.689
WRL-6-14	38.463	23.000	9.711
WRL-6-15	38.659	23.000	9.732

Designation	F.S.	B.L.	W.L.
WRL-6-16	38.854	23.000	9.751
WRL-6-17	39.049	23.000	9.767
WRL-6-18	39.244	23.000	9.778
WRL-6-19	39.440	23.000	9.782
WLU-1-1	23.241	-5.000	9.725
WLU-1-2	23.395	-5.000	9.844
WLU-1-3	23.578	-5.000	9.911
WLU-1-4	23.770	-5.000	9.950
WLU-1-5	23.963	-5.000	9.980
WLU-1-6	24.158	-5.000	10.003
WLU-1-7	24.352	-5.000	10.024
WLU-1-8	24.547	-5.000	10.042
WLU-1-9	24.742	-5.000	10.058
WLU-1-10	24.938	-5.000	10.073
WLU-1-11	25.133	-5.000	10.087
WLU-1-12	25.328	-5.000	10.100
WLU-1-13	25.524	-5.000	10.111
WLU-1-14	25.719	-5.000	10.120
WLU-1-15	25.915	-5.000	10.126
WLU-1-16	26.111	-5.000	10.129
WLU-1-17	26.306	-5.000	10.127
WLU-1-18	26.502	-5.000	10.125
WLU-1-19	26.698	-5.000	10.122
WLU-1-20	26.894	-5.000	10.119
WLU-1-21	27.089	-5.000	10.115
WLU-1-22	27.285	-5.000	10.112
WLU-1-23	27.481	-5.000	10.110
WLU-1-24	27.677	-5.000	10.105
WLU-1-25	27.872	-5.000	10.100
WLU-1-26	28.068	-5.000	10.094
WLU-1-27	28.264	-5.000	10.087
WLU-1-28	28.459	-5.000	10.076
WLU-1-29	28.654	-5.000	10.056
WLU-1-30	28.849	-5.000	10.035
WLU-1-31	29.043	-5.000	10.016
WLU-1-32	29.238	-5.000	9.995
WLU-1-33	29.432	-5.000	9.971
WLU-1-34	29.627	-5.000	9.947
WLU-1-35	29.821	-5.000	9.921
WLU-1-36	30.015	-5.000	9.895
WLU-1-37	30.208	-5.000	9.867
WLU-1-38	30.402	-5.000	9.837
WLU-1-39	30.594	-5.000	9.801
WLU-1-40	30.786	-5.000	9.760
WLU-2-1	25.440	-8.125	9.738
WLU-2-2	25.621	-8.125	9.818
WLU-2-3	25.811	-8.125	9.871
WLU-2-4	26.004	-8.125	9.918
WLU-2-5	26.198	-8.125	9.957
WLU-2-6	26.393	-8.125	9.991

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WLU-2-7	26.589	-8.125	10.018
WLU-2-8	26.785	-8.125	10.041
WLU-2-9	26.982	-8.125	10.060
WLU-2-10	27.180	-8.125	10.075
WLU-2-11	27.377	-8.125	10.087
WLU-2-12	27.575	-8.125	10.097
WLU-2-13	27.773	-8.125	10.105
WLU-2-14	27.971	-8.125	10.110
WLU-2-15	28.169	-8.125	10.112
WLU-2-16	28.367	-8.125	10.113
WLU-2-17	28.565	-8.125	10.111
WLU-2-18	28.762	-8.125	10.106
WLU-2-19	28.960	-8.125	10.099
WLU-2-20	29.158	-8.125	10.089
WLU-2-21	29.356	-8.125	10.078
WLU-2-22	29.553	-8.125	10.063
WLU-2-23	29.750	-8.125	10.047
WLU-2-24	29.947	-8.125	10.029
WLU-2-25	30.144	-8.125	10.009
WLU-2-26	30.341	-8.125	9.988
WLU-2-27	30.538	-8.125	9.966
WLU-2-28	30.734	-8.125	9.943
WLU-2-29	30.931	-8.125	9.919
WLU-2-30	31.127	-8.125	9.895
WLU-2-31	31.324	-8.125	9.870
WLU-2-32	31.520	-8.125	9.846
WLU-2-33	31.717	-8.125	9.822
WLU-2-34	31.913	-8.125	9.798
WLU-2-35	32.110	-8.125	9.775
WLU-2-36	32.306	-8.125	9.752
WLU-2-37	32.503	-8.125	9.731
WLU-3-1	28.157	-12.000	9.760
WLU-3-2	28.343	-12.000	9.833
WLU-3-3	28.536	-12.000	9.884
WLU-3-4	28.732	-12.000	9.927
WLU-3-5	28.929	-12.000	9.963
WLU-3-6	29.127	-12.000	9.993
WLU-3-7	29.325	-12.000	10.017
WLU-3-8	29.524	-12.000	10.035
WLU-3-9	29.724	-12.000	10.050
WLU-3-10	29.924	-12.000	10.062
WLU-3-11	30.124	-12.000	10.070
WLU-3-12	30.324	-12.000	10.076
WLU-3-13	30.524	-12.000	10.078
WLU-3-14	30.724	-12.000	10.078
WLU-3-15	30.924	-12.000	10.075
WLU-3-16	31.124	-12.000	10.070
WLU-3-17	31.324	-12.000	10.061
WLU-3-18	31.524	-12.000	10.050
WLU-3-19	31.724	-12.000	10.036

Designation	F.S.	B.L.	W.L.
WLU-3-20	31.923	-12.000	10.019
WLU-3-21	32.122	-12.000	10.001
WLU-3-22	32.321	-12.000	9.981
WLU-3-23	32.520	-12.000	9.959
WLU-3-24	32.719	-12.000	9.936
WLU-3-25	32.918	-12.000	9.912
WLU-3-26	33.116	-12.000	9.888
WLU-3-27	33.315	-12.000	9.864
WLU-3-28	33.514	-12.000	9.839
WLU-3-29	33.712	-12.000	9.815
WLU-3-30	33.911	-12.000	9.791
WLU-3-31	34.110	-12.000	9.768
WLU-3-32	34.309	-12.000	9.747
WLU-4-1	31.049	-16.125	9.782
WLU-4-2	31.239	-16.125	9.848
WLU-4-3	31.434	-16.125	9.895
WLU-4-4	31.631	-16.125	9.934
WLU-4-5	31.829	-16.125	9.965
WLU-4-6	32.029	-16.125	9.990
WLU-4-7	32.229	-16.125	10.009
WLU-4-8	32.429	-16.125	10.023
WLU-4-9	32.630	-16.125	10.033
WLU-4-10	32.831	-16.125	10.040
WLU-4-11	33.032	-16.125	10.042
WLU-4-12	33.232	-16.125	10.042
WLU-4-13	33.433	-16.125	10.038
WLU-4-14	33.634	-16.125	10.030
WLU-4-15	33.835	-16.125	10.020
WLU-4-16	34.035	-16.125	10.006
WLU-4-17	34.235	-16.125	9.990
WLU-4-18	34.435	-16.125	9.971
WLU-4-19	34.635	-16.125	9.950
WLU-4-20	34.835	-16.125	9.928
WLU-4-21	35.035	-16.125	9.905
WLU-4-22	35.234	-16.125	9.881
WLU-4-23	35.434	-16.125	9.857
WLU-4-24	35.633	-16.125	9.832
WLU-4-25	35.832	-16.125	9.808
WLU-4-26	36.032	-16.125	9.785
WLU-4-27	36.232	-16.125	9.764
WLU-5-1	33.817	-20.000	9.822
WLU-5-2	34.013	-20.000	9.873
WLU-5-3	34.211	-20.000	9.914
WLU-5-4	34.411	-20.000	9.946
WLU-5-5	34.611	-20.000	9.970
WLU-5-6	34.813	-20.000	9.988
WLU-5-7	35.015	-20.000	9.999
WLU-5-8	35.217	-20.000	10.006
WLU-5-9	35.419	-20.000	10.009
WLU-5-10	35.622	-20.000	10.007

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WLU-5-11	35.824	-20.000	10.001
WLU-5-12	36.026	-20.000	9.990
WLU-5-13	36.228	-20.000	9.977
WLU-5-14	36.429	-20.000	9.960
WLU-5-15	36.631	-20.000	9.941
WLU-5-16	36.832	-20.000	9.919
WLU-5-17	37.033	-20.000	9.897
WLU-5-18	37.234	-20.000	9.873
WLU-5-19	37.435	-20.000	9.849
WLU-5-20	37.636	-20.000	9.825
WLU-5-21	37.837	-20.000	9.801
WLU-5-22	38.038	-20.000	9.779
WLU-6-1	35.924	-23.000	9.834
WLU-6-2	36.115	-23.000	9.879
WLU-6-3	36.308	-23.000	9.915
WLU-6-4	36.503	-23.000	9.942
WLU-6-5	36.698	-23.000	9.962
WLU-6-6	36.895	-23.000	9.975
WLU-6-7	37.091	-23.000	9.981
WLU-6-8	37.287	-23.000	9.982
WLU-6-9	37.484	-23.000	9.978
WLU-6-10	37.680	-23.000	9.970
WLU-6-11	37.876	-23.000	9.958
WLU-6-12	38.072	-23.000	9.942
WLU-6-13	38.268	-23.000	9.923
WLU-6-14	38.463	-23.000	9.903
WLU-6-15	38.659	-23.000	9.881
WLU-6-16	38.854	-23.000	9.858
WLU-6-17	39.049	-23.000	9.835
WLU-6-18	39.244	-23.000	9.813
WLU-6-19	39.440	-23.000	9.791
WLL-1-1	23.241	-5.000	9.563
WLL-1-2	23.395	-5.000	9.484
WLL-1-3	23.578	-5.000	9.447
WLL-1-4	23.770	-5.000	9.426
WLL-1-5	23.963	-5.000	9.411
WLL-1-6	24.158	-5.000	9.397
WLL-1-7	24.352	-5.000	9.384
WLL-1-8	24.547	-5.000	9.373
WLL-1-9	24.742	-5.000	9.365
WLL-1-10	24.938	-5.000	9.357
WLL-1-11	25.133	-5.000	9.351
WLL-1-12	25.328	-5.000	9.346
WLL-1-13	25.524	-5.000	9.344
WLL-1-14	25.719	-5.000	9.344
WLL-1-15	25.915	-5.000	9.345
WLL-1-16	26.111	-5.000	9.348
WLL-1-17	26.306	-5.000	9.351
WLL-1-18	26.502	-5.000	9.357
WLL-1-19	26.698	-5.000	9.363

Designation	F.S.	B.L.	W.L.
WLL-1-20	26.894	-5.000	9.371
WLL-1-21	27.089	-5.000	9.381
WLL-1-22	27.285	-5.000	9.392
WLL-1-23	27.481	-5.000	9.402
WLL-1-24	27.677	-5.000	9.415
WLL-1-25	27.872	-5.000	9.426
WLL-1-26	28.068	-5.000	9.447
WLL-1-27	28.264	-5.000	9.472
WLL-1-28	28.459	-5.000	9.493
WLL-1-29	28.654	-5.000	9.517
WLL-1-30	28.849	-5.000	9.543
WLL-1-31	29.043	-5.000	9.569
WLL-1-32	29.238	-5.000	9.595
WLL-1-33	29.432	-5.000	9.620
WLL-1-34	29.627	-5.000	9.643
WLL-1-35	29.821	-5.000	9.664
WLL-1-36	30.015	-5.000	9.682
WLL-1-37	30.208	-5.000	9.696
WLL-1-38	30.402	-5.000	9.709
WLL-1-39	30.594	-5.000	9.722
WLL-1-40	30.786	-5.000	9.734
WLL-2-1	25.266	-7.875	9.596
WLL-2-2	25.448	-7.875	9.537
WLL-2-3	25.640	-7.875	9.504
WLL-2-4	25.834	-7.875	9.477
WLL-2-5	26.029	-7.875	9.454
WLL-2-6	26.226	-7.875	9.436
WLL-2-7	26.423	-7.875	9.422
WLL-2-8	26.622	-7.875	9.411
WLL-2-9	26.820	-7.875	9.403
WLL-2-10	27.019	-7.875	9.397
WLL-2-11	27.218	-7.875	9.394
WLL-2-12	27.418	-7.875	9.393
WLL-2-13	27.617	-7.875	9.394
WLL-2-14	27.817	-7.875	9.396
WLL-2-15	28.016	-7.875	9.400
WLL-2-16	28.216	-7.875	9.406
WLL-2-17	28.415	-7.875	9.413
WLL-2-18	28.615	-7.875	9.423
WLL-2-19	28.814	-7.875	9.434
WLL-2-20	29.013	-7.875	9.447
WLL-2-21	29.213	-7.875	9.461
WLL-2-22	29.412	-7.875	9.478
WLL-2-23	29.611	-7.875	9.496
WLL-2-24	29.809	-7.875	9.514
WLL-2-25	30.008	-7.875	9.534
WLL-2-26	30.206	-7.875	9.555
WLL-2-27	30.405	-7.875	9.576
WLL-2-28	30.603	-7.875	9.597
WLL-2-29	30.801	-7.875	9.617

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WLL-2-30	30.999	-7.875	9.638
WLL-2-31	31.197	-7.875	9.657
WLL-2-32	31.395	-7.875	9.675
WLL-2-33	31.593	-7.875	9.691
WLL-2-34	31.791	-7.875	9.704
WLL-2-35	31.989	-7.875	9.714
WLL-2-36	32.187	-7.875	9.719
WLL-2-37	32.386	-7.875	9.721
WLL-3-1	28.157	-12.000	9.627
WLL-3-2	28.343	-12.000	9.570
WLL-3-3	28.536	-12.000	9.540
WLL-3-4	28.732	-12.000	9.516
WLL-3-5	28.929	-12.000	9.497
WLL-3-6	29.127	-12.000	9.482
WLL-3-7	29.325	-12.000	9.471
WLL-3-8	29.524	-12.000	9.463
WLL-3-9	29.724	-12.000	9.457
WLL-3-10	29.924	-12.000	9.455
WLL-3-11	30.124	-12.000	9.454
WLL-3-12	30.324	-12.000	9.456
WLL-3-13	30.524	-12.000	9.459
WLL-3-14	30.724	-12.000	9.465
WLL-3-15	30.924	-12.000	9.473
WLL-3-16	31.124	-12.000	9.482
WLL-3-17	31.324	-12.000	9.495
WLL-3-18	31.524	-12.000	9.509
WLL-3-19	31.724	-12.000	9.525
WLL-3-20	31.923	-12.000	9.543
WLL-3-21	32.122	-12.000	9.563
WLL-3-22	32.321	-12.000	9.583
WLL-3-23	32.520	-12.000	9.604
WLL-3-24	32.719	-12.000	9.625
WLL-3-25	32.918	-12.000	9.646
WLL-3-26	33.116	-12.000	9.666
WLL-3-27	33.315	-12.000	9.686
WLL-3-28	33.514	-12.000	9.703
WLL-3-29	33.712	-12.000	9.717
WLL-3-30	33.911	-12.000	9.729
WLL-3-31	34.110	-12.000	9.735
WLL-3-32	34.309	-12.000	9.737
WLL-4-1	30.899	-15.875	9.645
WLL-4-2	31.094	-15.875	9.598
WLL-4-3	31.294	-15.875	9.572
WLL-4-4	31.494	-15.875	9.552
WLL-4-5	31.695	-15.875	9.537
WLL-4-6	31.896	-15.875	9.525
WLL-4-7	32.097	-15.875	9.518
WLL-4-8	32.298	-15.875	9.513
WLL-4-9	32.500	-15.875	9.511
WLL-4-10	32.701	-15.875	9.512

Designation	F.S.	B.L.	W.L.
WLL-4-11	32.902	-15.875	9.515
WLL-4-12	33.104	-15.875	9.521
WLL-4-13	33.305	-15.875	9.529
WLL-4-14	33.506	-15.875	9.541
WLL-4-15	33.707	-15.875	9.554
WLL-4-16	33.908	-15.875	9.571
WLL-4-17	34.108	-15.875	9.589
WLL-4-18	34.309	-15.875	9.609
WLL-4-19	34.509	-15.875	9.630
WLL-4-20	34.709	-15.875	9.652
WLL-4-21	34.909	-15.875	9.673
WLL-4-22	35.110	-15.875	9.694
WLL-4-23	35.310	-15.875	9.713
WLL-4-24	35.511	-15.875	9.729
WLL-4-25	35.712	-15.875	9.742
WLL-4-26	35.913	-15.875	9.750
WLL-4-27	36.114	-15.875	9.753
WLL-5-1	33.817	-20.000	9.665
WLL-5-2	34.013	-20.000	9.632
WLL-5-3	34.211	-20.000	9.612
WLL-5-4	34.411	-20.000	9.596
WLL-5-5	34.611	-20.000	9.585
WLL-5-6	34.813	-20.000	9.577
WLL-5-7	35.015	-20.000	9.573
WLL-5-8	35.217	-20.000	9.572
WLL-5-9	35.419	-20.000	9.575
WLL-5-10	35.622	-20.000	9.580
WLL-5-11	35.824	-20.000	9.590
WLL-5-12	36.026	-20.000	9.602
WLL-5-13	36.228	-20.000	9.619
WLL-5-14	36.429	-20.000	9.638
WLL-5-15	36.631	-20.000	9.659
WLL-5-16	36.832	-20.000	9.681
WLL-5-17	37.033	-20.000	9.702
WLL-5-18	37.234	-20.000	9.723
WLL-5-19	37.435	-20.000	9.741
WLL-5-20	37.636	-20.000	9.756
WLL-5-21	37.837	-20.000	9.766
WLL-5-22	38.038	-20.000	9.770
WLL-6-1	35.924	-23.000	9.697
WLL-6-2	36.115	-23.000	9.662
WLL-6-3	36.308	-23.000	9.645
WLL-6-4	36.503	-23.000	9.632
WLL-6-5	36.698	-23.000	9.623
WLL-6-6	36.895	-23.000	9.618
WLL-6-7	37.091	-23.000	9.616
WLL-6-8	37.287	-23.000	9.618
WLL-6-9	37.484	-23.000	9.625
WLL-6-10	37.680	-23.000	9.635
WLL-6-11	37.876	-23.000	9.650

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
WLL-6-12	38.072	-23.000	9.669
WLL-6-13	38.268	-23.000	9.689
WLL-6-14	38.463	-23.000	9.711
WLL-6-15	38.659	-23.000	9.732
WLL-6-16	38.854	-23.000	9.751
WLL-6-17	39.049	-23.000	9.767
WLL-6-18	39.244	-23.000	9.778
WLL-6-19	39.440	-23.000	9.782
HRU-1-1	34.811	4.000	9.617
HRU-1-2	35.021	4.000	9.629
HRU-1-3	35.231	4.000	9.640
HRU-1-4	35.442	4.000	9.651
HRU-1-5	35.652	4.000	9.661
HRU-1-6	35.862	4.000	9.670
HRU-1-7	36.073	4.000	9.679
HRU-1-8	36.283	4.000	9.686
HRU-1-9	36.493	4.000	9.693
HRU-1-10	36.704	4.000	9.699
HRU-1-11	36.914	4.000	9.704
HRU-1-12	37.125	4.000	9.709
HRU-1-13	37.335	4.000	9.713
HRU-1-14	37.546	4.000	9.716
HRU-1-15	37.756	4.000	9.718
HRU-1-16	37.967	4.000	9.720
HRU-1-17	38.177	4.000	9.721
HRU-1-18	38.388	4.000	9.721
HRU-1-19	38.598	4.000	9.720
HRU-1-20	38.809	4.000	9.718
HRU-1-21	39.019	4.000	9.714
HRU-1-22	39.230	4.000	9.710
HRU-1-23	39.440	4.000	9.704
HRU-1-24	39.651	4.000	9.697
HRU-1-25	39.861	4.000	9.690
HRU-1-26	40.071	4.000	9.681
HRU-1-27	40.282	4.000	9.671
HRU-1-28	40.492	4.000	9.661
HRU-1-29	40.702	4.000	9.650
HRU-1-30	40.912	4.000	9.638
HRU-1-31	41.123	4.000	9.626
HRU-1-32	41.333	4.000	9.613
HRU-1-33	41.543	4.000	9.600
HRU-1-34	41.753	4.000	9.586
HRU-1-35	41.963	4.000	9.572
HRU-1-36	42.173	4.000	9.556
HRU-1-37	42.383	4.000	9.540
HRU-1-38	42.593	4.000	9.523
HRU-1-39	42.802	4.000	9.506
HRU-2-1	37.182	5.500	9.557
HRU-2-2	37.390	5.500	9.568
HRU-2-3	37.597	5.500	9.579

Designation	F.S.	B.L.	W.L.
HRU-2-4	37.805	5.500	9.588
HRU-2-5	38.012	5.500	9.597
HRU-2-6	38.220	5.500	9.604
HRU-2-7	38.428	5.500	9.610
HRU-2-8	38.635	5.500	9.616
HRU-2-9	38.843	5.500	9.620
HRU-2-10	39.051	5.500	9.624
HRU-2-11	39.259	5.500	9.626
HRU-2-12	39.467	5.500	9.628
HRU-2-13	39.674	5.500	9.629
HRU-2-14	39.882	5.500	9.630
HRU-2-15	40.090	5.500	9.629
HRU-2-16	40.298	5.500	9.627
HRU-2-17	40.505	5.500	9.623
HRU-2-18	40.713	5.500	9.619
HRU-2-19	40.921	5.500	9.612
HRU-2-20	41.129	5.500	9.605
HRU-2-21	41.336	5.500	9.596
HRU-2-22	41.544	5.500	9.586
HRU-2-23	41.751	5.500	9.574
HRU-2-24	41.959	5.500	9.562
HRU-2-25	42.166	5.500	9.549
HRU-2-26	42.373	5.500	9.536
HRU-2-27	42.581	5.500	9.522
HRU-2-28	42.788	5.500	9.507
HRU-2-29	42.995	5.500	9.492
HRU-2-30	43.202	5.500	9.476
HRU-3-1	39.557	7.000	9.498
HRU-3-2	39.770	7.000	9.508
HRU-3-3	39.983	7.000	9.516
HRU-3-4	40.196	7.000	9.523
HRU-3-5	40.409	7.000	9.529
HRU-3-6	40.622	7.000	9.533
HRU-3-7	40.836	7.000	9.536
HRU-3-8	41.049	7.000	9.538
HRU-3-9	41.262	7.000	9.539
HRU-3-10	41.475	7.000	9.539
HRU-3-11	41.688	7.000	9.537
HRU-3-12	41.901	7.000	9.532
HRU-3-13	42.114	7.000	9.524
HRU-3-14	42.327	7.000	9.514
HRU-3-15	42.540	7.000	9.501
HRU-3-16	42.753	7.000	9.488
HRU-3-17	42.966	7.000	9.474
HRU-3-18	43.178	7.000	9.460
HRU-3-19	43.391	7.000	9.447
HRL-1-1	34.811	4.000	9.600
HRL-1-2	35.021	4.000	9.581
HRL-1-3	35.231	4.000	9.562
HRL-1-4	35.442	4.000	9.543

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
HRL-1-5	35.652	4.000	9.526
HRL-1-6	35.862	4.000	9.510
HRL-1-7	36.073	4.000	9.496
HRL-1-8	36.283	4.000	9.482
HRL-1-9	36.493	4.000	9.470
HRL-1-10	36.704	4.000	9.459
HRL-1-11	36.914	4.000	9.448
HRL-1-12	37.125	4.000	9.438
HRL-1-13	37.335	4.000	9.429
HRL-1-14	37.546	4.000	9.421
HRL-1-15	37.756	4.000	9.413
HRL-1-16	37.967	4.000	9.406
HRL-1-17	38.177	4.000	9.400
HRL-1-18	38.388	4.000	9.394
HRL-1-19	38.598	4.000	9.389
HRL-1-20	38.809	4.000	9.385
HRL-1-21	39.019	4.000	9.382
HRL-1-22	39.230	4.000	9.380
HRL-1-23	39.440	4.000	9.379
HRL-1-24	39.651	4.000	9.379
HRL-1-25	39.861	4.000	9.380
HRL-1-26	40.071	4.000	9.382
HRL-1-27	40.282	4.000	9.385
HRL-1-28	40.492	4.000	9.388
HRL-1-29	40.702	4.000	9.393
HRL-1-30	40.912	4.000	9.398
HRL-1-31	41.123	4.000	9.404
HRL-1-32	41.333	4.000	9.411
HRL-1-33	41.543	4.000	9.419
HRL-1-34	41.753	4.000	9.427
HRL-1-35	41.963	4.000	9.437
HRL-1-36	42.173	4.000	9.448
HRL-1-37	42.383	4.000	9.461
HRL-1-38	42.593	4.000	9.475
HRL-1-39	42.802	4.000	9.489
HRL-2-1	37.182	5.500	9.542
HRL-2-2	37.390	5.500	9.524
HRL-2-3	37.597	5.500	9.507
HRL-2-4	37.805	5.500	9.490
HRL-2-5	38.012	5.500	9.475
HRL-2-6	38.220	5.500	9.462
HRL-2-7	38.428	5.500	9.450
HRL-2-8	38.635	5.500	9.439
HRL-2-9	38.843	5.500	9.429
HRL-2-10	39.051	5.500	9.420
HRL-2-11	39.259	5.500	9.412
HRL-2-12	39.467	5.500	9.404
HRL-2-13	39.674	5.500	9.398
HRL-2-14	39.882	5.500	9.392
HRL-2-15	40.090	5.500	9.387

Designation	F.S.	B.L.	W.L.
HRL-2-16	40.298	5.500	9.383
HRL-2-17	40.505	5.500	9.380
HRL-2-18	40.713	5.500	9.378
HRL-2-19	40.921	5.500	9.377
HRL-2-20	41.129	5.500	9.379
HRL-2-21	41.336	5.500	9.381
HRL-2-22	41.544	5.500	9.385
HRL-2-23	41.751	5.500	9.391
HRL-2-24	41.959	5.500	9.397
HRL-2-25	42.166	5.500	9.405
HRL-2-26	42.373	5.500	9.413
HRL-2-27	42.581	5.500	9.423
HRL-2-28	42.788	5.500	9.434
HRL-2-29	42.995	5.500	9.447
HRL-2-30	43.202	5.500	9.461
HRL-3-1	39.557	7.000	9.484
HRL-3-2	39.770	7.000	9.467
HRL-3-3	39.983	7.000	9.452
HRL-3-4	40.196	7.000	9.439
HRL-3-5	40.409	7.000	9.427
HRL-3-6	40.622	7.000	9.417
HRL-3-7	40.836	7.000	9.409
HRL-3-8	41.049	7.000	9.400
HRL-3-9	41.262	7.000	9.393
HRL-3-10	41.475	7.000	9.387
HRL-3-11	41.688	7.000	9.383
HRL-3-12	41.901	7.000	9.381
HRL-3-13	42.114	7.000	9.382
HRL-3-14	42.327	7.000	9.387
HRL-3-15	42.540	7.000	9.394
HRL-3-16	42.753	7.000	9.403
HRL-3-17	42.966	7.000	9.413
HRL-3-18	43.178	7.000	9.423
HRL-3-19	43.391	7.000	9.435
HLU-1-1	34.699	-4.000	9.646
HLU-1-2	34.911	-4.000	9.659
HLU-1-3	35.124	-4.000	9.670
HLU-1-4	35.336	-4.000	9.681
HLU-1-5	35.549	-4.000	9.691
HLU-1-6	35.762	-4.000	9.700
HLU-1-7	35.975	-4.000	9.708
HLU-1-8	36.188	-4.000	9.715
HLU-1-9	36.400	-4.000	9.722
HLU-1-10	36.613	-4.000	9.727
HLU-1-11	36.826	-4.000	9.732
HLU-1-12	37.039	-4.000	9.737
HLU-1-13	37.252	-4.000	9.741
HLU-1-14	37.465	-4.000	9.744
HLU-1-15	37.678	-4.000	9.746
HLU-1-16	37.891	-4.000	9.747

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
HLU-1-17	38.104	-4.000	9.747
HLU-1-18	38.317	-4.000	9.746
HLU-1-19	38.530	-4.000	9.744
HLU-1-20	38.743	-4.000	9.742
HLU-1-21	38.956	-4.000	9.738
HLU-1-22	39.169	-4.000	9.733
HLU-1-23	39.381	-4.000	9.727
HLU-1-24	39.594	-4.000	9.720
HLU-1-25	39.807	-4.000	9.713
HLU-1-26	40.020	-4.000	9.704
HLU-1-27	40.233	-4.000	9.694
HLU-1-28	40.445	-4.000	9.684
HLU-1-29	40.658	-4.000	9.673
HLU-1-30	40.871	-4.000	9.661
HLU-1-31	41.083	-4.000	9.648
HLU-1-32	41.296	-4.000	9.635
HLU-1-33	41.508	-4.000	9.621
HLU-1-34	41.721	-4.000	9.607
HLU-1-35	41.933	-4.000	9.591
HLU-1-36	42.145	-4.000	9.575
HLU-1-37	42.358	-4.000	9.557
HLU-1-38	42.570	-4.000	9.539
HLU-1-39	42.782	-4.000	9.520
HLU-2-1	37.048	-5.500	9.592
HLU-2-2	37.260	-5.500	9.603
HLU-2-3	37.471	-5.500	9.613
HLU-2-4	37.683	-5.500	9.623
HLU-2-5	37.894	-5.500	9.631
HLU-2-6	38.105	-5.500	9.638
HLU-2-7	38.317	-5.500	9.644
HLU-2-8	38.529	-5.500	9.650
HLU-2-9	38.740	-5.500	9.655
HLU-2-10	38.952	-5.500	9.658
HLU-2-11	39.163	-5.500	9.661
HLU-2-12	39.375	-5.500	9.663
HLU-2-13	39.587	-5.500	9.664
HLU-2-14	39.798	-5.500	9.663
HLU-2-15	40.010	-5.500	9.661
HLU-2-16	40.221	-5.500	9.658
HLU-2-17	40.433	-5.500	9.654
HLU-2-18	40.644	-5.500	9.648
HLU-2-19	40.856	-5.500	9.642
HLU-2-20	41.067	-5.500	9.634
HLU-2-21	41.279	-5.500	9.624
HLU-2-22	41.490	-5.500	9.614
HLU-2-23	41.702	-5.500	9.603
HLU-2-24	41.913	-5.500	9.591
HLU-2-25	42.124	-5.500	9.578
HLU-2-26	42.335	-5.500	9.563
HLU-2-27	42.546	-5.500	9.548

Designation	F.S.	B.L.	W.L.
HLU-2-28	42.757	-5.500	9.532
HLU-2-29	42.968	-5.500	9.515
HLU-2-30	43.179	-5.500	9.497
HLU-3-1	39.405	-7.000	9.539
HLU-3-2	39.630	-7.000	9.548
HLU-3-3	39.855	-7.000	9.556
HLU-3-4	40.080	-7.000	9.564
HLU-3-5	40.304	-7.000	9.570
HLU-3-6	40.529	-7.000	9.575
HLU-3-7	40.754	-7.000	9.579
HLU-3-8	40.979	-7.000	9.581
HLU-3-9	41.204	-7.000	9.581
HLU-3-10	41.428	-7.000	9.579
HLU-3-11	41.653	-7.000	9.575
HLU-3-12	41.878	-7.000	9.568
HLU-3-13	42.103	-7.000	9.560
HLU-3-14	42.327	-7.000	9.550
HLU-3-15	42.552	-7.000	9.538
HLU-3-16	42.776	-7.000	9.524
HLU-3-17	43.001	-7.000	9.508
HLU-3-18	43.225	-7.000	9.492
HLU-3-19	43.449	-7.000	9.476
HLL-1-1	34.699	-4.000	9.630
HLL-1-2	34.911	-4.000	9.612
HLL-1-3	35.124	-4.000	9.594
HLL-1-4	35.336	-4.000	9.576
HLL-1-5	35.549	-4.000	9.559
HLL-1-6	35.762	-4.000	9.543
HLL-1-7	35.975	-4.000	9.528
HLL-1-8	36.188	-4.000	9.514
HLL-1-9	36.400	-4.000	9.500
HLL-1-10	36.613	-4.000	9.487
HLL-1-11	36.826	-4.000	9.475
HLL-1-12	37.039	-4.000	9.464
HLL-1-13	37.252	-4.000	9.453
HLL-1-14	37.465	-4.000	9.444
HLL-1-15	37.678	-4.000	9.435
HLL-1-16	37.891	-4.000	9.427
HLL-1-17	38.104	-4.000	9.421
HLL-1-18	38.317	-4.000	9.415
HLL-1-19	38.530	-4.000	9.410
HLL-1-20	38.743	-4.000	9.406
HLL-1-21	38.956	-4.000	9.403
HLL-1-22	39.169	-4.000	9.401
HLL-1-23	39.381	-4.000	9.401
HLL-1-24	39.594	-4.000	9.401
HLL-1-25	39.807	-4.000	9.403
HLL-1-26	40.020	-4.000	9.405
HLL-1-27	40.233	-4.000	9.408
HLL-1-28	40.445	-4.000	9.412

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
HLL-1-29	40.658	-4.000	9.416
HLL-1-30	40.871	-4.000	9.421
HLL-1-31	41.083	-4.000	9.426
HLL-1-32	41.296	-4.000	9.432
HLL-1-33	41.508	-4.000	9.439
HLL-1-34	41.721	-4.000	9.447
HLL-1-35	41.933	-4.000	9.456
HLL-1-36	42.145	-4.000	9.466
HLL-1-37	42.358	-4.000	9.478
HLL-1-38	42.570	-4.000	9.491
HLL-1-39	42.782	-4.000	9.504
HLL-2-1	37.048	-5.500	9.578
HLL-2-2	37.260	-5.500	9.560
HLL-2-3	37.471	-5.500	9.543
HLL-2-4	37.683	-5.500	9.527
HLL-2-5	37.894	-5.500	9.512
HLL-2-6	38.105	-5.500	9.498
HLL-2-7	38.317	-5.500	9.485
HLL-2-8	38.529	-5.500	9.472
HLL-2-9	38.740	-5.500	9.461
HLL-2-10	38.952	-5.500	9.451
HLL-2-11	39.163	-5.500	9.442
HLL-2-12	39.375	-5.500	9.434
HLL-2-13	39.587	-5.500	9.427
HLL-2-14	39.798	-5.500	9.421
HLL-2-15	40.010	-5.500	9.416
HLL-2-16	40.221	-5.500	9.412
HLL-2-17	40.433	-5.500	9.410
HLL-2-18	40.644	-5.500	9.409
HLL-2-19	40.856	-5.500	9.409
HLL-2-20	41.067	-5.500	9.410
HLL-2-21	41.279	-5.500	9.412
HLL-2-22	41.490	-5.500	9.415
HLL-2-23	41.702	-5.500	9.419
HLL-2-24	41.913	-5.500	9.424
HLL-2-25	42.124	-5.500	9.430
HLL-2-26	42.335	-5.500	9.438
HLL-2-27	42.546	-5.500	9.447
HLL-2-28	42.757	-5.500	9.457
HLL-2-29	42.968	-5.500	9.469
HLL-2-30	43.179	-5.500	9.482
HLL-3-1	39.405	-7.000	9.525
HLL-3-2	39.630	-7.000	9.509
HLL-3-3	39.855	-7.000	9.493
HLL-3-4	40.080	-7.000	9.479
HLL-3-5	40.304	-7.000	9.466
HLL-3-6	40.529	-7.000	9.454
HLL-3-7	40.754	-7.000	9.444
HLL-3-8	40.979	-7.000	9.436
HLL-3-9	41.204	-7.000	9.429

Designation	F.S.	B.L.	W.L.
HLL-3-10	41.428	-7.000	9.424
HLL-3-11	41.653	-7.000	9.420
HLL-3-12	41.878	-7.000	9.418
HLL-3-13	42.103	-7.000	9.419
HLL-3-14	42.327	-7.000	9.421
HLL-3-15	42.552	-7.000	9.425
HLL-3-16	42.776	-7.000	9.432
HLL-3-17	43.001	-7.000	9.441
HLL-3-18	43.225	-7.000	9.452
HLL-3-19	43.449	-7.000	9.463
VR-1-1	33.152	-0.026	10.500
VR-1-2	33.424	-0.016	10.500
VR-1-3	33.696	-0.007	10.500
VR-1-4	33.968	0.003	10.500
VR-1-5	34.240	0.013	10.500
VR-1-6	34.512	0.022	10.500
VR-1-7	34.784	0.031	10.500
VR-1-8	35.056	0.040	10.500
VR-1-9	35.328	0.049	10.500
VR-1-10	35.599	0.057	10.500
VR-1-11	35.871	0.065	10.500
VR-1-12	36.143	0.073	10.500
VR-1-13	36.415	0.080	10.500
VR-1-14	36.687	0.087	10.500
VR-1-15	36.959	0.093	10.500
VR-1-16	37.231	0.099	10.500
VR-1-17	37.503	0.104	10.500
VR-1-18	37.775	0.108	10.500
VR-1-19	38.047	0.112	10.500
VR-1-20	38.319	0.115	10.500
VR-1-21	38.591	0.118	10.500
VR-1-22	38.863	0.119	10.500
VR-1-23	39.135	0.120	10.500
VR-1-24	39.408	0.119	10.500
VR-1-25	39.680	0.118	10.500
VR-1-26	39.952	0.115	10.500
VR-1-27	40.224	0.110	10.500
VR-1-28	40.496	0.104	10.500
VR-1-29	40.768	0.096	10.500
VR-1-30	41.039	0.085	10.500
VR-1-31	41.311	0.074	10.500
VR-1-32	41.583	0.060	10.500
VR-1-33	41.855	0.045	10.500
VR-1-34	42.126	0.029	10.500
VR-1-35	42.398	0.011	10.500
VR-1-36	42.669	-0.008	10.500
VR-1-37	42.940	-0.028	10.500
VR-2-1	35.275	-0.024	12.000
VR-2-2	35.543	-0.014	12.000
VR-2-3	35.811	-0.005	12.000

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
VR-2-4	36.079	0.004	12.000
VR-2-5	36.347	0.013	12.000
VR-2-6	36.615	0.022	12.000
VR-2-7	36.884	0.031	12.000
VR-2-8	37.152	0.039	12.000
VR-2-9	37.420	0.048	12.000
VR-2-10	37.688	0.055	12.000
VR-2-11	37.956	0.063	12.000
VR-2-12	38.224	0.070	12.000
VR-2-13	38.492	0.077	12.000
VR-2-14	38.760	0.083	12.000
VR-2-15	39.028	0.089	12.000
VR-2-16	39.296	0.094	12.000
VR-2-17	39.564	0.097	12.000
VR-2-18	39.833	0.100	12.000
VR-2-19	40.101	0.101	12.000
VR-2-20	40.369	0.101	12.000
VR-2-21	40.637	0.098	12.000
VR-2-22	40.905	0.094	12.000
VR-2-23	41.173	0.088	12.000
VR-2-24	41.441	0.080	12.000
VR-2-25	41.709	0.070	12.000
VR-2-26	41.977	0.059	12.000
VR-2-27	42.245	0.045	12.000
VR-2-28	42.513	0.030	12.000
VR-2-29	42.780	0.014	12.000
VR-2-30	43.048	-0.005	12.000
VR-2-31	43.315	-0.024	12.000
VR-3-1	37.403	-0.018	13.500
VR-3-2	37.676	-0.009	13.500
VR-3-3	37.949	0.000	13.500
VR-3-4	38.223	0.009	13.500
VR-3-5	38.496	0.018	13.500
VR-3-6	38.769	0.026	13.500
VR-3-7	39.042	0.035	13.500
VR-3-8	39.315	0.043	13.500
VR-3-9	39.589	0.050	13.500
VR-3-10	39.862	0.057	13.500
VR-3-11	40.135	0.063	13.500
VR-3-12	40.409	0.067	13.500
VR-3-13	40.682	0.070	13.500
VR-3-14	40.955	0.072	13.500
VR-3-15	41.228	0.073	13.500
VR-3-16	41.502	0.071	13.500
VR-3-17	41.775	0.068	13.500
VR-3-18	42.048	0.063	13.500
VR-3-19	42.322	0.055	13.500
VR-3-20	42.595	0.046	13.500
VR-3-21	42.868	0.034	13.500
VR-3-22	43.141	0.019	13.500

Designation	F.S.	B.L.	W.L.
VR-3-23	43.414	0.002	13.500
VR-3-24	43.686	-0.017	13.500
VR-4-1	39.248	-0.010	14.800
VR-4-2	39.528	-0.001	14.800
VR-4-3	39.807	0.008	14.800
VR-4-4	40.087	0.016	14.800
VR-4-5	40.367	0.024	14.800
VR-4-6	40.646	0.032	14.800
VR-4-7	40.926	0.039	14.800
VR-4-8	41.206	0.044	14.800
VR-4-9	41.486	0.049	14.800
VR-4-10	41.765	0.052	14.800
VR-4-11	42.045	0.054	14.800
VR-4-12	42.325	0.053	14.800
VR-4-13	42.605	0.049	14.800
VR-4-14	42.885	0.042	14.800
VR-4-15	43.164	0.032	14.800
VR-4-16	43.444	0.019	14.800
VR-4-17	43.723	0.002	14.800
VR-4-18	44.002	-0.017	14.800
VL-1-1	33.152	-0.039	10.500
VL-1-2	33.424	-0.049	10.500
VL-1-3	33.696	-0.059	10.500
VL-1-4	33.968	-0.069	10.500
VL-1-5	34.240	-0.079	10.500
VL-1-6	34.512	-0.090	10.500
VL-1-7	34.784	-0.100	10.500
VL-1-8	35.056	-0.110	10.500
VL-1-9	35.328	-0.119	10.500
VL-1-10	35.599	-0.129	10.500
VL-1-11	35.871	-0.139	10.500
VL-1-12	36.143	-0.148	10.500
VL-1-13	36.415	-0.156	10.500
VL-1-14	36.687	-0.164	10.500
VL-1-15	36.959	-0.172	10.500
VL-1-16	37.231	-0.178	10.500
VL-1-17	37.503	-0.184	10.500
VL-1-18	37.775	-0.188	10.500
VL-1-19	38.047	-0.192	10.500
VL-1-20	38.319	-0.195	10.500
VL-1-21	38.591	-0.196	10.500
VL-1-22	38.863	-0.197	10.500
VL-1-23	39.135	-0.197	10.500
VL-1-24	39.408	-0.196	10.500
VL-1-25	39.680	-0.195	10.500
VL-1-26	39.952	-0.192	10.500
VL-1-27	40.224	-0.189	10.500
VL-1-28	40.496	-0.183	10.500
VL-1-29	40.768	-0.176	10.500
VL-1-30	41.039	-0.168	10.500

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
VL-1-31	41.311	-0.157	10.500
VL-1-32	41.583	-0.145	10.500
VL-1-33	41.855	-0.130	10.500
VL-1-34	42.126	-0.114	10.500
VL-1-35	42.398	-0.096	10.500
VL-1-36	42.669	-0.077	10.500
VL-1-37	42.940	-0.058	10.500
VL-2-1	35.275	-0.039	12.000
VL-2-2	35.543	-0.049	12.000
VL-2-3	35.811	-0.059	12.000
VL-2-4	36.079	-0.069	12.000
VL-2-5	36.347	-0.079	12.000
VL-2-6	36.615	-0.089	12.000
VL-2-7	36.884	-0.098	12.000
VL-2-8	37.152	-0.107	12.000
VL-2-9	37.420	-0.116	12.000
VL-2-10	37.688	-0.124	12.000
VL-2-11	37.956	-0.132	12.000
VL-2-12	38.224	-0.139	12.000
VL-2-13	38.492	-0.146	12.000
VL-2-14	38.760	-0.152	12.000
VL-2-15	39.028	-0.157	12.000
VL-2-16	39.296	-0.161	12.000
VL-2-17	39.564	-0.165	12.000
VL-2-18	39.833	-0.168	12.000
VL-2-19	40.101	-0.170	12.000
VL-2-20	40.369	-0.170	12.000
VL-2-21	40.637	-0.169	12.000
VL-2-22	40.905	-0.166	12.000
VL-2-23	41.173	-0.161	12.000
VL-2-24	41.441	-0.153	12.000
VL-2-25	41.709	-0.144	12.000
VL-2-26	41.977	-0.133	12.000
VL-2-27	42.245	-0.120	12.000
VL-2-28	42.513	-0.105	12.000
VL-2-29	42.780	-0.089	12.000
VL-2-30	43.048	-0.072	12.000
VL-2-31	43.315	-0.053	12.000
VL-3-1	37.403	-0.036	13.500
VL-3-2	37.676	-0.046	13.500
VL-3-3	37.949	-0.055	13.500
VL-3-4	38.223	-0.065	13.500
VL-3-5	38.496	-0.075	13.500
VL-3-6	38.769	-0.084	13.500
VL-3-7	39.042	-0.093	13.500
VL-3-8	39.315	-0.101	13.500
VL-3-9	39.589	-0.109	13.500
VL-3-10	39.862	-0.117	13.500
VL-3-11	40.135	-0.124	13.500
VL-3-12	40.409	-0.130	13.500

Designation	F.S.	B.L.	W.L.
VL-3-13	40.682	-0.134	13.500
VL-3-14	40.955	-0.137	13.500
VL-3-15	41.228	-0.138	13.500
VL-3-16	41.502	-0.137	13.500
VL-3-17	41.775	-0.133	13.500
VL-3-18	42.048	-0.127	13.500
VL-3-19	42.322	-0.120	13.500
VL-3-20	42.595	-0.110	13.500
VL-3-21	42.868	-0.098	13.500
VL-3-22	43.141	-0.084	13.500
VL-3-23	43.414	-0.068	13.500
VL-3-24	43.686	-0.050	13.500
VL-4-1	39.248	-0.032	14.800
VL-4-2	39.528	-0.043	14.800
VL-4-3	39.807	-0.054	14.800
VL-4-4	40.087	-0.064	14.800
VL-4-5	40.367	-0.075	14.800
VL-4-6	40.646	-0.084	14.800
VL-4-7	40.926	-0.092	14.800
VL-4-8	41.206	-0.099	14.800
VL-4-9	41.486	-0.104	14.800
VL-4-10	41.765	-0.107	14.800
VL-4-11	42.045	-0.108	14.800
VL-4-12	42.325	-0.107	14.800
VL-4-13	42.605	-0.104	14.800
VL-4-14	42.885	-0.098	14.800
VL-4-15	43.164	-0.089	14.800
VL-4-16	43.444	-0.077	14.800
VL-4-17	43.723	-0.063	14.800
VL-4-18	44.002	-0.046	14.800
FL-1-1	0.463	0.000	7.265
FL-1-2	0.841	0.000	7.134
FL-1-3	1.225	0.000	7.016
FL-1-4	1.612	0.000	6.914
FL-1-5	2.003	0.000	6.825
FL-1-6	2.396	0.000	6.744
FL-1-7	2.791	0.000	6.673
FL-1-8	3.187	0.000	6.615
FL-1-9	3.586	0.000	6.569
FL-1-10	3.985	0.000	6.535
FL-1-11	4.385	0.000	6.509
FL-1-12	4.786	0.000	6.492
FL-1-13	5.187	0.000	6.480
FL-1-14	5.588	0.000	6.473
FL-1-15	5.988	0.000	6.472
FL-1-16	6.389	0.000	6.476
FL-1-17	6.790	0.000	6.485
FL-1-18	7.191	0.000	6.500
FL-1-19	7.592	0.000	6.518
FL-1-20	7.992	0.000	6.539

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
FL-1-21	8.392	0.000	6.560
FL-1-22	8.793	0.000	6.581
FL-1-23	9.193	0.000	6.599
FL-1-24	9.594	0.000	6.616
FL-1-25	9.995	0.000	6.629
FL-1-26	10.396	0.000	6.639
FL-1-27	10.796	0.000	6.646
FL-1-28	11.197	0.000	6.651
FL-1-29	11.598	0.000	6.658
FL-1-30	11.999	0.000	6.662
FL-1-31	12.400	0.000	6.668
FL-1-32	12.801	0.000	6.674
FL-1-33	13.202	0.000	6.679
FL-1-34	13.603	0.000	6.684
FL-1-35	14.004	0.000	6.689
FL-1-36	14.405	0.000	6.695
FL-1-37	14.806	0.000	6.699
FL-1-38	15.207	0.000	6.703
FL-1-39	15.608	0.000	6.709
FL-1-40	16.009	0.000	6.713
FL-1-41	16.410	0.000	6.717
FL-1-42	16.811	0.000	6.722
FL-1-43	17.212	0.000	6.726
FL-1-44	17.613	0.000	6.730
FL-1-45	18.013	0.000	6.735
FL-1-46	18.414	0.000	6.738
FL-1-47	18.815	0.000	6.741
FL-1-48	19.216	0.000	6.743
FL-1-49	19.617	0.000	6.746
FL-1-50	20.018	0.000	6.748
FL-1-51	20.419	0.000	6.753
FL-1-52	20.820	0.000	6.758
FL-1-53	21.221	0.000	6.763
FL-1-54	21.622	0.000	6.768
FL-1-55	22.023	0.000	6.773
FL-1-56	22.424	0.000	6.777
FL-1-57	22.825	0.000	6.782
FL-1-58	23.226	0.000	6.788
FL-1-59	23.627	0.000	6.793
FL-1-60	24.028	0.000	6.798
FL-1-61	24.429	0.000	6.803
FL-1-62	24.830	0.000	6.809
FL-1-63	25.231	0.000	6.815
FL-1-64	25.632	0.000	6.819
FL-1-65	26.032	0.000	6.824
FL-1-66	26.433	0.000	6.827
FL-1-67	26.834	0.000	6.831
FL-1-68	27.235	0.000	6.832
FL-1-69	27.636	0.000	6.832
FL-1-70	28.037	0.000	6.832

Designation	F.S.	B.L.	W.L.
FL-1-71	28.438	0.000	6.831
FL-1-72	28.839	0.000	6.829
FL-1-73	29.240	0.000	6.829
FL-1-74	29.641	0.000	6.829
FL-1-75	30.042	0.000	6.829
FL-1-76	30.443	0.000	6.830
FL-1-77	30.844	0.000	6.831
FL-1-78	31.245	0.000	6.832
FL-1-79	31.646	0.000	6.832
FL-1-80	32.047	0.000	6.832
FL-1-81	32.448	0.000	6.833
FL-1-82	32.849	0.000	6.834
FL-1-83	33.250	0.000	6.835
FL-1-84	33.651	0.000	6.836
FL-1-85	34.052	0.000	6.837
FL-1-86	34.451	0.000	6.808
FL-1-87	34.846	0.000	6.743
FL-1-88	35.247	0.000	6.733
FL-1-89	35.648	0.000	6.733
FL-1-90	36.049	0.000	6.733
FL-1-91	36.450	0.000	6.733
FL-1-92	36.851	0.000	6.733
FL-1-93	37.252	0.000	6.732
FL-1-94	37.653	0.000	6.732
FL-1-95	38.054	0.000	6.732
FL-1-96	38.455	0.000	6.730
FL-1-97	38.856	0.000	6.730
FL-1-98	39.257	0.000	6.729
FL-1-99	39.657	0.000	6.729
FL-1-100	40.058	0.000	6.728
FL-1-101	40.459	0.000	6.726
FL-1-102	40.860	0.000	6.723
FL-1-103	41.261	0.000	6.720
FL-1-104	41.662	0.000	6.717
FL-1-105	42.063	0.000	6.712
FL-1-106	42.464	0.000	6.707
FL-1-107	42.865	0.000	6.701
FU-1-1	0.463	0.000	7.498
FU-1-2	0.841	0.000	7.631
FU-1-3	1.225	0.000	7.739
FU-1-4	1.612	0.000	7.837
FU-1-5	2.003	0.000	7.925
FU-1-6	2.396	0.000	8.010
FU-1-7	2.791	0.000	8.093
FU-1-8	3.187	0.000	8.174
FU-1-9	3.586	0.000	8.255
FU-1-10	3.985	0.000	8.336
FU-1-11	4.385	0.000	8.418
FU-1-12	4.786	0.000	8.502
FU-1-13	5.187	0.000	8.584

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
FU-1-14	5.588	0.000	8.664
FU-1-15	5.988	0.000	8.745
FU-1-16	6.389	0.000	8.825
FU-1-17	6.790	0.000	8.904
FU-1-18	7.191	0.000	8.981
FU-1-19	7.592	0.000	9.057
FU-1-20	7.992	0.000	9.132
FU-1-21	8.392	0.000	9.201
FU-1-22	8.793	0.000	9.268
FU-1-23	9.193	0.000	9.367
FU-1-24	9.594	0.000	9.531
FU-1-25	9.995	0.000	9.696
FU-1-26	10.396	0.000	9.858
FU-1-27	10.796	0.000	10.019
FU-1-28	11.197	0.000	10.177
FU-1-29	11.598	0.000	10.335
FU-1-30	11.999	0.000	10.490
FU-1-31	12.400	0.000	10.627
FU-1-32	12.801	0.000	10.738
FU-1-33	13.202	0.000	10.820
FU-1-34	13.603	0.000	10.878
FU-1-35	14.004	0.000	10.920
FU-1-36	14.405	0.000	10.952
FU-1-37	14.806	0.000	10.974
FU-1-38	15.207	0.000	10.987
FU-1-39	15.608	0.000	10.993
FU-1-40	16.009	0.000	10.992
FU-1-41	16.410	0.000	10.986
FU-1-42	16.811	0.000	10.974
FU-1-43	17.212	0.000	10.957
FU-1-44	17.613	0.000	10.939
FU-1-45	18.013	0.000	10.918
FU-1-46	18.414	0.000	10.896
FU-1-47	18.815	0.000	10.871
FU-1-48	19.216	0.000	10.845
FU-1-49	19.617	0.000	10.818
FU-1-50	20.018	0.000	10.789
FU-1-51	20.419	0.000	10.758
FU-1-52	20.820	0.000	10.725
FU-1-53	21.221	0.000	10.692
FU-1-54	21.622	0.000	10.660
FU-1-55	22.023	0.000	10.629
FU-1-56	22.424	0.000	10.600
FU-1-57	22.825	0.000	10.571
FU-1-58	23.226	0.000	10.544
FU-1-59	23.627	0.000	10.518
FU-1-60	24.028	0.000	10.493
FU-1-61	24.429	0.000	10.468
FU-1-62	24.830	0.000	10.443
FU-1-63	25.231	0.000	10.420

Designation	F.S.	B.L.	W.L.
FU-1-64	25.632	0.000	10.396
FU-1-65	26.032	0.000	10.376
FU-1-66	26.433	0.000	10.361
FU-1-67	26.834	0.000	10.349
FU-1-68	27.235	0.000	10.338
FU-1-69	27.636	0.000	10.328
FU-1-70	28.037	0.000	10.318
FU-1-71	28.438	0.000	10.307
FU-1-72	28.839	0.000	10.297
FU-1-73	29.240	0.000	10.286
FU-1-74	29.641	0.000	10.274
FU-1-75	30.042	0.000	10.261
FU-1-76	30.443	0.000	10.247
FU-1-77	30.844	0.000	10.235
FU-1-78	31.245	0.000	10.222
FU-1-79	31.646	0.000	10.210
FU-1-80	32.047	0.000	10.200
FU-1-81	32.448	0.000	10.189
FX-1-1	16.000	0.118	10.985
FX-1-2	16.000	0.408	10.939
FX-1-3	16.000	0.688	10.852
FX-1-4	16.000	0.953	10.724
FX-1-5	16.000	1.192	10.555
FX-1-6	16.000	1.412	10.360
FX-1-7	16.000	1.667	10.215
FX-1-8	16.000	1.930	10.086
FX-1-9	16.000	2.184	9.938
FX-1-10	16.000	2.092	9.761
FX-1-11	16.000	1.809	9.684
FX-1-12	16.000	1.713	9.451
FX-1-13	16.000	1.700	9.157
FX-1-14	16.000	1.683	8.864
FX-1-15	16.000	1.667	8.571
FX-1-16	16.000	1.651	8.277
FX-1-17	16.000	1.634	7.984
FX-1-18	16.000	1.613	7.691
FX-1-19	16.000	1.568	7.401
FX-1-20	16.000	1.457	7.130
FX-1-21	16.000	1.265	6.911
FX-1-22	16.000	1.006	6.774
FX-1-23	16.000	0.718	6.721
FX-1-24	16.000	0.424	6.716
FX-1-25	16.000	0.131	6.713
FX-1-26	16.000	-0.163	6.712
FX-1-27	16.000	-0.457	6.714
FX-1-28	16.000	-0.751	6.717
FX-1-29	16.000	-1.041	6.758
FX-1-30	16.000	-1.305	6.883
FX-1-31	16.000	-1.510	7.092
FX-1-32	16.000	-1.633	7.357

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
FX-1-33	16.000	-1.685	7.646
FX-1-34	16.000	-1.708	7.939
FX-1-35	16.000	-1.724	8.232
FX-1-36	16.000	-1.738	8.526
FX-1-37	16.000	-1.753	8.819
FX-1-38	16.000	-1.770	9.112
FX-1-39	16.000	-1.784	9.406
FX-1-40	16.000	-1.835	9.676
FX-1-41	16.000	-2.119	9.749
FX-1-42	16.000	-2.287	9.916
FX-1-43	16.000	-2.036	10.069
FX-1-44	16.000	-1.774	10.200
FX-1-45	16.000	-1.517	10.342
FX-1-46	16.000	-1.294	10.533
FX-1-47	16.000	-1.058	10.708
FX-1-48	16.000	-0.796	10.840
FX-1-49	16.000	-0.517	10.931
FX-1-50	16.000	-0.228	10.981
FX-2-1	18.000	-0.175	10.915
FX-2-2	18.000	-0.467	10.879
FX-2-3	18.000	-0.752	10.808
FX-2-4	18.000	-1.026	10.703
FX-2-5	18.000	-1.293	10.578
FX-2-6	18.000	-1.560	10.455
FX-2-7	18.000	-1.836	10.354
FX-2-8	18.000	-2.116	10.265
FX-2-9	18.000	-2.392	10.162
FX-2-10	18.000	-2.660	10.043
FX-2-11	18.000	-2.922	9.909
FX-2-12	18.000	-2.903	9.733
FX-2-13	18.000	-2.624	9.639
FX-2-14	18.000	-2.337	9.578
FX-2-15	18.000	-2.047	9.532
FX-2-16	18.000	-1.820	9.424
FX-2-17	18.000	-1.798	9.131
FX-2-18	18.000	-1.779	8.838
FX-2-19	18.000	-1.761	8.544
FX-2-20	18.000	-1.741	8.251
FX-2-21	18.000	-1.721	7.958
FX-2-22	18.000	-1.698	7.664
FX-2-23	18.000	-1.659	7.373
FX-2-24	18.000	-1.556	7.099
FX-2-25	18.000	-1.361	6.883
FX-2-26	18.000	-1.092	6.770
FX-2-27	18.000	-0.800	6.738
FX-2-28	18.000	-0.506	6.736
FX-2-29	18.000	-0.212	6.735
FX-2-30	18.000	0.082	6.734
FX-2-31	18.000	0.376	6.736
FX-2-32	18.000	0.670	6.739

Designation	F.S.	B.L.	W.L.
FX-2-33	18.000	0.963	6.759
FX-2-34	18.000	1.240	6.854
FX-2-35	18.000	1.453	7.052
FX-2-36	18.000	1.568	7.321
FX-2-37	18.000	1.616	7.611
FX-2-38	18.000	1.641	7.904
FX-2-39	18.000	1.661	8.197
FX-2-40	18.000	1.681	8.491
FX-2-41	18.000	1.701	8.784
FX-2-42	18.000	1.720	9.077
FX-2-43	18.000	1.739	9.371
FX-2-44	18.000	1.915	9.521
FX-2-45	18.000	2.207	9.561
FX-2-46	18.000	2.496	9.614
FX-2-47	18.000	2.777	9.697
FX-2-48	18.000	2.919	9.867
FX-2-49	18.000	2.661	10.006
FX-2-50	18.000	2.393	10.129
FX-2-51	18.000	2.120	10.236
FX-2-52	18.000	1.840	10.327
FX-2-53	18.000	1.563	10.424
FX-2-54	18.000	1.293	10.542
FX-2-55	18.000	1.029	10.671
FX-2-56	18.000	0.758	10.784
FX-2-57	18.000	0.475	10.864
FX-2-58	18.000	0.185	10.909
FX-3-1	20.000	0.119	10.787
FX-3-2	20.000	0.412	10.751
FX-3-3	20.000	0.699	10.686
FX-3-4	20.000	0.983	10.607
FX-3-5	20.000	1.267	10.524
FX-3-6	20.000	1.552	10.448
FX-3-7	20.000	1.839	10.382
FX-3-8	20.000	2.128	10.322
FX-3-9	20.000	2.416	10.258
FX-3-10	20.000	2.701	10.183
FX-3-11	20.000	2.982	10.092
FX-3-12	20.000	3.259	9.989
FX-3-13	20.000	3.529	9.873
FX-3-14	20.000	3.610	9.683
FX-3-15	20.000	3.334	9.580
FX-3-16	20.000	3.047	9.513
FX-3-17	20.000	2.755	9.470
FX-3-18	20.000	2.761	9.193
FX-3-19	20.000	2.762	8.898
FX-3-20	20.000	2.699	8.611
FX-3-21	20.000	2.536	8.366
FX-3-22	20.000	2.315	8.173
FX-3-23	20.000	2.048	8.051
FX-3-24	20.000	1.757	8.002

Table 1. Continued
a. Continued

Designation	F.S.	B.L.	W.L.
FX-3-25	20.000	1.640	7.788
FX-3-26	20.000	1.618	7.494
FX-3-27	20.000	1.566	7.204
FX-3-28	20.000	1.432	6.945
FX-3-29	20.000	1.183	6.793
FX-3-30	20.000	0.892	6.756
FX-3-31	20.000	0.597	6.751
FX-3-32	20.000	0.302	6.749
FX-3-33	20.000	0.007	6.748
FX-3-34	20.000	-0.288	6.749
FX-3-35	20.000	-0.583	6.750
FX-3-36	20.000	-0.879	6.753
FX-3-37	20.000	-1.172	6.772
FX-3-38	20.000	-1.440	6.891
FX-3-39	20.000	-1.612	7.126
FX-3-40	20.000	-1.681	7.411
FX-3-41	20.000	-1.705	7.705
FX-3-42	20.000	-1.740	7.990
FX-3-43	20.000	-2.032	8.031
FX-3-44	20.000	-2.310	8.127
FX-3-45	20.000	-2.551	8.295
FX-3-46	20.000	-2.730	8.529
FX-3-47	20.000	-2.831	8.804
FX-3-48	20.000	-2.848	9.098
FX-3-49	20.000	-2.808	9.390
FX-3-50	20.000	-3.031	9.506
FX-3-51	20.000	-3.319	9.569
FX-3-52	20.000	-3.598	9.662
FX-3-53	20.000	-3.660	9.838
FX-3-54	20.000	-3.392	9.963
FX-3-55	20.000	-3.117	10.068
FX-3-56	20.000	-2.837	10.162
FX-3-57	20.000	-2.552	10.239
FX-3-58	20.000	-2.265	10.306
FX-3-59	20.000	-1.976	10.366
FX-3-60	20.000	-1.688	10.430
FX-3-61	20.000	-1.403	10.504
FX-3-62	20.000	-1.119	10.586
FX-3-63	20.000	-0.836	10.669
FX-3-64	20.000	-0.549	10.738
FX-3-65	20.000	-0.258	10.782
FX-4-1	22.000	-0.177	10.627
FX-4-2	22.000	-0.471	10.596
FX-4-3	22.000	-0.764	10.548
FX-4-4	22.000	-1.056	10.498
FX-4-5	22.000	-1.349	10.452
FX-4-6	22.000	-1.643	10.413
FX-4-7	22.000	-1.938	10.381
FX-4-8	22.000	-2.233	10.353
FX-4-9	22.000	-2.528	10.324

Designation	F.S.	B.L.	W.L.
FX-4-10	22.000	-2.822	10.287
FX-4-11	22.000	-3.114	10.239
FX-4-12	22.000	-3.404	10.176
FX-4-13	22.000	-3.692	10.104
FX-4-14	22.000	-3.976	10.021
FX-4-15	22.000	-4.245	9.897
FX-4-16	22.000	-4.447	9.692
FX-4-17	22.000	-4.224	9.524
FX-4-18	22.000	-3.935	9.459
FX-4-19	22.000	-3.647	9.411
FX-4-20	22.000	-3.645	9.116
FX-4-21	22.000	-3.636	8.821
FX-4-22	22.000	-3.577	8.530
FX-4-23	22.000	-3.468	8.255
FX-4-24	22.000	-3.314	8.003
FX-4-25	22.000	-3.112	7.787
FX-4-26	22.000	-2.872	7.612
FX-4-27	22.000	-2.606	7.483
FX-4-28	22.000	-2.324	7.393
FX-4-29	22.000	-2.033	7.335
FX-4-30	22.000	-1.739	7.303
FX-4-31	22.000	-1.628	7.038
FX-4-32	22.000	-1.419	6.840
FX-4-33	22.000	-1.130	6.780
FX-4-34	22.000	-0.834	6.774
FX-4-35	22.000	-0.537	6.773
FX-4-36	22.000	-0.241	6.773
FX-4-37	22.000	0.056	6.772
FX-4-38	22.000	0.352	6.772
FX-4-39	22.000	0.649	6.774
FX-4-40	22.000	0.945	6.774
FX-4-41	22.000	1.239	6.801
FX-4-42	22.000	1.499	6.934
FX-4-43	22.000	1.618	7.202
FX-4-44	22.000	1.854	7.312
FX-4-45	22.000	2.146	7.360
FX-4-46	22.000	2.430	7.444
FX-4-47	22.000	2.703	7.559
FX-4-48	22.000	2.953	7.717
FX-4-49	22.000	3.169	7.919
FX-4-50	22.000	3.340	8.161
FX-4-51	22.000	3.466	8.429
FX-4-52	22.000	3.544	8.714
FX-4-53	22.000	3.573	9.009
FX-4-54	22.000	3.570	9.305
FX-4-55	22.000	3.775	9.427
FX-4-56	22.000	4.066	9.482
FX-4-57	22.000	4.336	9.596
FX-4-58	22.000	4.266	9.834
FX-4-59	22.000	4.006	9.976

Table 1. Continued
a. Concluded

Designation	F.S.	B.L.	W.L.
FX-4-60	22.000	3.725	10.070
FX-4-61	22.000	3.438	10.145
FX-4-62	22.000	3.149	10.211
FX-4-63	22.000	2.858	10.266
FX-4-64	22.000	2.564	10.307
FX-4-65	22.000	2.270	10.339
FX-4-66	22.000	1.975	10.369
FX-4-67	22.000	1.680	10.402
FX-4-68	22.000	1.386	10.440
FX-4-69	22.000	1.093	10.484
FX-4-70	22.000	0.801	10.532
FX-4-71	22.000	0.508	10.582
FX-4-72	22.000	0.215	10.621

Table 1. Concluded
b. Model Pressure Orifices

Designation	F.S.	B.L.	W.L.
CWIU1	25.621	8.121	9.818
CWIU2	25.751	8.094	9.861
CWIU3	26.084	8.100	9.938
CWIU4	26.424	8.100	9.998
CWIU5	26.769	8.097	10.042
CWIU6	27.437	8.083	10.092
CWIU7	28.091	8.090	10.112
CWIU8	28.759	8.076	10.106
CWIU9	29.427	8.116	10.072
CWIU10	30.123	8.116	10.011
CWIU11	30.770	8.085	9.936
CWIL1	25.459	7.849	9.531
CWIL2	25.585	7.836	9.508
CWIL3	25.925	7.826	9.461
CWIL4	26.247	7.834	9.432
CWIL5	26.598	7.847	9.411
CWIL6	27.260	7.841	9.393
CWIL7	27.944	7.835	9.399
CWIL8	28.600	7.848	9.422
CWIL9	29.280	7.838	9.468
CWIL10	29.950	7.866	9.529
CWIL11	30.627	7.846	9.600
CWOU1	31.180	-16.143	9.828
CWOU2	31.276	-16.132	9.857
CWOU3	31.520	-16.143	9.911
CWOU4	31.807	-16.154	9.959
CWOU5	32.046	-16.150	9.990
CWOU6	32.555	-16.145	10.029
CWOU7	33.061	-16.146	10.042
CWOU8	33.567	-16.140	10.033
CWOU9	34.094	-16.139	10.002
CWOU10	34.585	-16.168	9.958
CWOU11	35.110	-16.135	9.896
CWOL1	30.991	-15.888	9.618
CWOL2	31.081	-15.889	9.601
CWOL3	31.336	-15.876	9.568
CWOL4	31.614	-15.878	9.543
CWOL5	31.858	-15.876	9.527
CWOL6	32.357	-15.895	9.513
CWOL7	32.876	-15.879	9.515
CWOL8	33.391	-15.880	9.534
CWOL9	33.899	-15.912	9.569
CWOL10	34.413	-15.888	9.619
CWOL11	34.937	-15.890	9.675
CFL1	20.015	-0.025	6.748
CFL2	24.535	-0.022	6.805
CFL3	29.018	-0.042	6.830
CFL4	34.052	0.808	6.944
CFL5	34.050	-0.912	6.956

Table 2. Paint Calibration Coefficients

Coefficient \ Subscript	1	2	3	4
a	-6.35589E+02	1.21793E+01	-1.24007E-01	4.32677E-04
b	1.01216E+03	-2.27270E+01	2.31811E-01	-7.98981E-04
c	-3.51380E+02	1.35776E+01	-1.42748E-01	4.80971E-04
d	1.01600E+02	-3.55983E+00	3.77434E-02	-1.29570E-04
e	-9.26667E+00	3.15839E-01	-3.37185E-03	1.16801E-05

Table 3. Nominal Test Conditions

Mach Number	Total Pressure, psfa	Total Temperature, °F	Free-stream Temperature, °R	Free-stream Pressure, psfa	Dynamic Pressure, psf	Reynolds Number, $x10^{-6}$
0.4	2150	90	533	1924	217	2.5
0.8	1347	100	496	884	396	2.5
0.95	1250	100	474	498	443	2.5
1.1	1207	100	451	565	479	2.5

Table 4. Run Number Summary

RUN	POINT	M	ALPHA	Avg offset, psf	%slope change
272	1	0.40	-2.0	-15.9	-2.1
272	2	0.40	0.0	-9.1	27.9
272	3	0.40	2.0	-15.0	7.1
272	4	0.40	4.0	-16.9	3.7
272	5	0.40	6.0	-19.8	3.6
272	6	0.40	8.0	-22.8	0.2
272	7	0.40	10.0	-18.1	2.5
272	8	0.40	14.0	-23.1	-1.5
272	9	0.40	20.0	-25.5	1.6
272	10	0.40	28.0	-23.3	1.9
272	11	0.40	36.0	-24.0	2.0
272	12	0.40	40.0	-30.0	4.2
344	1	0.80	-3.0	-19.4	-4.2
344	5	0.80	1.0	-0.6	6.4
344	6	0.80	2.0	-0.6	2.1
344	7	0.80	3.0	1.4	3.6
344	8	0.80	4.0	1.3	3.4
344	9	0.80	5.0	-5.5	0.2
344	10	0.80	6.0	-0.9	0.9
344	11	0.80	7.0	-5.6	-0.4
345	1	0.80	10.0	-2.2	0.1
345	2	0.80	12.0	-4.5	0.2
345	3	0.80	14.0	-2.6	1.1
345	4	0.80	16.0	-1.0	1.9
345	5	0.80	18.0	-3.8	-0.7
345	6	0.80	20.0	-4.0	-0.1
345	7	0.80	24.0	-9.2	-0.5
345	8	0.80	28.1	-23.4	-3.7
345	9	0.80	32.1	-19.6	-3.9
345	10	0.80	36.0	-34.8	-4.9
346	1	0.95	-3.0	-24.8	-7.2
346	2	0.95	-2.0	-21.3	-8.2
346	3	0.95	-1.0	-21.7	-6.9
346	4	0.95	0.0	-18.0	-5.5
346	5	0.95	1.0	-16.4	-4.3
346	6	0.95	2.0	-15.9	-3.4
346	7	0.95	3.0	-10.6	-0.9
346	8	0.95	4.0	-3.9	1.1
346	9	0.95	5.0	-6.1	2.7
346	10	0.95	6.0	-5.1	0.2
346	11	0.95	7.0	-4.0	0.4
346	12	0.95	8.0	-3.2	0.9
346	13	0.95	9.0	-4.1	0.8
346	14	0.95	10.0	-2.3	2.0
346	15	0.95	12.0	-3.4	2.0
346	16	0.95	14.0	-2.6	3.7
346	17	0.95	16.0	-4.4	2.3
346	18	0.95	18.0	0.2	2.6
346	19	0.95	20.0	-4.1	3.9

RUN	POINT	M	ALPHA	Avg offset, psf	%slope change
346	20	0.95	24.1	-2.6	4.0
346	21	0.95	28.1	-1.4	2.6
346	22	0.95	32.1	0.1	2.4
347	1	1.10	-3.1	-16.1	-5.6
347	2	1.10	-2.0	-15.9	-5.5
347	3	1.10	-1.0	-17.1	-6.6
347	4	1.10	0.0	-16.8	-5.8
347	5	1.10	1.0	-18.3	-5.5
347	6	1.10	2.0	-13.8	-3.4
347	7	1.10	3.0	-13.1	-3.1
347	8	1.10	4.0	-9.8	-1.4
347	9	1.10	5.0	-9.3	-0.7
347	10	1.10	6.0	-8.1	-0.4
347	11	1.10	7.0	-8.6	-1.0
347	12	1.10	8.0	-4.6	1.2
347	13	1.10	9.0	-3.3	1.3
347	14	1.10	10.0	0.0	2.8
347	15	1.10	12.0	-1.3	2.3
347	16	1.10	14.0	-3.5	1.5
347	17	1.10	16.0	-3.9	1.8
347	18	1.10	18.0	-3.5	2.4
347	19	1.10	20.0	-0.4	2.5
347	20	1.10	24.0	0.0	2.7
348	1	0.95	-3.0	-10.9	-4.3
348	2	0.95	-2.0	-9.4	-5.7
348	3	0.95	-1.0	-9.3	-4.6
348	4	0.95	0.0	-11.9	-4.7
348	5	0.95	1.0	-9.3	-4.2
348	6	0.95	2.0	-7.6	-3.1
348	7	0.95	3.0	-0.7	0.6
348	8	0.95	4.0	0.0	1.7
348	9	0.95	5.0	3.4	1.7
349	1	0.95	8.0	9.2	3.8
349	2	0.95	10.0	8.3	3.7
349	3	0.95	14.1	6.4	4.5
349	4	0.95	20.1	7.2	7.3
349	5	0.95	28.0	10.8	5.2
350	2	0.80	0.0	20.3	10.6
350	3	0.80	2.0	31.3	11.2
350	4	0.80	4.0	28.9	5.5
350	5	0.80	6.0	27.4	5.9
351	1	0.80	10.0	27.3	5.1
351	2	0.80	14.1	29.5	7.9
351	3	0.80	20.1	27.4	5.2
351	4	0.80	28.0	26.7	7.5
351	5	0.80	36.0	26.7	5.4

NOMENCLATURE

a_x, b_x, c_x, d_x, e_x	PSP lifetime calibration coefficients, where x = 1-4 (see Eq. [3], Table 2)
Alpha	Model angle of attack, deg
Beta	Model side slip angle, deg
B.L.	Model buttock line, model scale in.
CFLx	Model fuselage pressure orifices, where x = 1-5 (see Table 1b)
CP	Surface pressure coefficient, $(P - P_\infty) / Q_\infty$
CWILx	Model wing inboard lower pressure orifices, where x = 1-11 (see Table 1b)
CWIUx	Model wing inboard upper pressure orifices, where x = 1-11 (see Table 1b)
CWOLx	Model wing outboard lower pressure orifices, where x = 1-11 (see Table 1b)
CWOUx	Model wing outboard upper pressure orifices, where x = 1-11 (see Table 1b)
FIB7	Proprietary polymer developed by the University of Washington
FL-1-y	Virtual fuselage pressure orifices along bottom centerline, y is orifice number (see Table 1)
F.S.	Model fuselage station, model scale in.
FX-x-y	Virtual fuselage pressure orifices, where x is fuselage station cut number and y is orifice number (see Table 1a)
FU-1-y	Virtual fuselage pressure orifices along top centerline, y is orifice number (see Table 1a)
Gate1,2	Image acquired at different times relative to excitation pulse
HAAS	High Angle Automated Sting
HLL-x-y	Virtual left lower horizontal pressure orifices, where x is horizontal B.L. cut number and y is orifice number (see Table 1a)
HLU-x-y	Virtual left upper horizontal pressure orifices, where x is horizontal B.L. cut number and y is orifice number (see Table 1a)
HRL-x-y	Virtual right lower horizontal pressure orifices, where x is horizontal B.L. cut number and y is orifice number (see Table 1a)
HRU-x-y	Virtual right upper horizontal pressure orifices, where x is horizontal B.L. cut number and y is orifice number (see Table 1a)
I	Paint luminescence intensity at pressure, wind-on condition
I_0	Paint luminescence intensity in the absence of oxygen
I_{Dark}	Dark current intensity in the absence of illumination
I_{Gate_x}	Paint luminescence intensity for Gate 1 and 2
IR	Intensity ratio, Gate 1/Gate 2
LED	Light emitting diode

LW	Left wing
Mach	Freestream Mach number
P	Surface pressure at wind-on condition, psfa
P_∞	Freestream static pressure, psfa
PSP	Pressure-sensitive paint
Re/ft	Freestream unit Reynolds number, ft^{-1}
RW	Right wing
Q_∞	Freestream dynamic pressure, psf
r	Temperature recovery factor (see Eq. [7])
s_0, s_1	Slope correction terms (see Eq. [4], Fig. 7)
t	Time, sec
$T, T_{surface}$	PSP calibration or model surface temperature, °F
T_∞	Freestream temperature, °F
TT	Tunnel stagnation temperature, °F
VL-x-y	Virtual left vertical tail pressure orifices, where x is vertical tail W.L. cut number and y is orifice number (see Table 1a)
VR-x-y	Virtual right vertical tail pressure orifices, where x is vertical tail W.L. cut number and y is orifice number (see Table 1a)
W.L.	Model water line, model scale in.
WLL-x-y	Virtual left lower wing pressure orifices, where x is wing B.L. cut number and y is orifice number (see Table 1a)
WLU-x-y	Virtual left upper wing pressure orifices, where x is wing B.L. cut number and y is orifice number (see Table 1a)
WRL-x-y	Virtual right lower wing pressure orifices, where x is wing B.L. cut number and y is orifice number (see Table 1a)
WRU-x-y	Virtual right upper wing pressure orifices, where x is wing B.L. cut number and y is orifice number (see Table 1a)
X/C	Ratio of distance from wing leading edge to the chord at B.L. station
σ	Standard deviation
τ	PSP lifetime, sec